ICESAT/GLAS
Science Computing Facility

IDL Visualization Software User's Guide

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1.0 Introduction

This version of the GLAS Data Visualizer is fully written in IDL to allow users to use the free IDL Virtual Machine. Unlike the previous IDL Visualizer made available through NSIDC, it has all the subsetting capabilities of the Full Visualizer version available only to the GLAS Science Team written in IDL, Fortran 90, and Tcl/Tk. It has many new design features and only a couple of disadvantages compared with the full version.

Advantages:

- Fully written in IDL so users without an IDL license can use it via the free IDL Virtual Machine.
- Able to display geographically and temporally subsetted data.
- Able to select different parameters without starting IDL over again.
- Able to select all data in a laser period that formerly needed a database.
- Browse product button added to main data selection page and if selected, browse product display appears with data plot sets.
- Faster overall, although some tasks may be a bit slower (i.e. obtaining tracks).
- Hourglasses have been added to indicate slower functions.

Disadvantages:

- Selecting data from a full laser period that formerly needed the database to access is slow but doable. When working with these data, it will be quicker to use the Full Visualizer if available.
- Removed capability to create subsetted product files (available on Full Visualizer only).

Note: The database management system files, starting with BN, GR, PS, and UR have to be present for every GLA product file for the "Subset Data" option to work. If these files are not present, the product files can still be visualized using the "Select Specific Files" option.

2.0 Installing and Running the Data Visualization Software

2.1 UNIX Operating System

To install the visualization software in the Unix environment just complete the following steps:

The data visualization software is delivered as a **tar** file, compressed with the Unix **gzip** utility. Copy the tar file to the directory you want the software to be in (<*path*>). To uncompress and expand the file, type the following at the Unix prompt:

$ **gunzip idl_visualizer_<*date*>.tar.gz**
$ **tar xvf idl_visualizer_<*date*>.tar**

Where <***date***> is the version of the visualization software used.
e.g., idl_visualizer_20101101.tar.gzip.

Note that an **idl_visualizer** directory will be created with subdirectories and files underneath it.

Once the files are successfully extracted from the tar file, it can be removed to save space.

The following subdirectories and files will be extracted under the **idl_visualizer** directory:

- **anc**
- **color_table**
- **common**
- **data –** directory with example data files
- **data_selection**
- **dem**
- **help**
- **images**
- **map**
- **orbit**
- **parameters –** directory where parameter files are stored
- **revfile**
- **scf_visualizer**
- **stations –** directory where station files are stored
- **README –** Quick Start Guide containing installation chapters from User's Guide.
- **icesatvis_ds.sav -** file to run the visualizer via the IDL Virtual Machine.
- **icesatvis_ds.pro**
- **make_IDL_tarfile.ksh**
- **make_save_file.ksh**

- **make_save_file.tcl**
- **run_ds**
- **run_visualizer.ksh –** script to run the visualizer on a Unix system.
- **run_vm_visualizer.ksh -** script to run the visualizer via the IDL Virtual Machine on a Unix system.
- set_env_pc.pro **–** file needed to run the visualizer on the PC.
- **SCF_IDL_DVUG.doc** – User's Guide (Microsoft Word document)

2.1.1 Fully Licensed IDL

- In **run_visualizer.ksh** change DIR_MAIN to the main path.

- To run the Data Visualizer, in the **idl_visualizer** directory type:

  $ **run_visualizer.ksh**

  or type:

  $ <***path***>**/idl_visualizer/run_visualizer.ksh** from any directory on the Unix system.

2.1.2 IDL Virtual Machine

- Make sure you have the IDL virtual machine installed.
  If not, you can download it for free at
  http://www.ittvis.com/ProductsServices/IDL/IDLModules/IDLVirtualMachine.aspx

- In **run_vm_visualizer.ksh** change DIR_MAIN to the main path.

- To run the IDL virtual machine version of the Data Visualizer, in the **idl_visualizer** directory type:

  $ **run_vm_visualizer.ksh**

  or type:

  $ <***path***>**/idl_visualizer/run_vm_visualizer.ksh** from any directory on the Unix system.

- Click on the IDL splash screen. Note that this may be hidden behind other windows.

2.2 PC/Mac Operating Systems

To install the visualization software in the PC or Mac environment just complete the following steps:

- User needs a licensed IDL software version 6.1 or higher already installed on the PC's hard drive.
- Copy the visualization software to the PC and uncompress and untar the delivered tar file using IZArc or other PC utility.

**** Important note about unpacking the tar file:

Some Windows unpacking programs (e.g. WinZip) perform a LineFeed->CarriageReturn/LineFeed conversion by default.

This must be disabled before the file is uncompressed or the sample data files will appear to be corrupted.

To disable in WinZip, select Options --> Configuration --> Miscellaneous tab.
Uncheck the TAR file smart CR/LF conversion option.

If using another Windows-based zip utility, look for a similar option.

IZArc does not do this conversion. To extract using IZArc simply double-click on the tar file and press "Extract".

****

2.2.1 Fully Licensed IDL

- Go to folder **idl_visualizer** (Note: Some unpacking programs may create an extra directory named after the tar file – take this into account when setting the IDL path below).
- Bring up IDL software by double-clicking on the **icesatvis_ds.pro** file or on the IDL icon.
- Select "Window" – "Preferences" then "IDL" and change the following:
  - Startup File: browse to the **icesatvis_ds.pro** file in the **idl_visualizer** directory
  - Initial Working Directory: browse to the **idl_visualizer** directory
  - Paths: (in pull-down menu) insert **idl_visualizer** directory into path. Check box to add subdirectories.
- Either change the current directory at the bottom of the window to the **idl_visualizer** directory or exit IDL and get back into it.
- Type **icesatvis_ds** at the "IDL>" prompt.

2.2.2 IDL Virtual Machine

- Make sure you have the IDL virtual machine (VM) installed.
  If not, you can download it for free at http://www.ittvis.com/idlvm/

- Make sure the **icesatvis_ds.sav** file exists in the **idl_visualizer** directory.

On the PC:

- Either:
  - Browse to the **idl_visualizer** directory and double-click on the **icesatvis_ds.sav** file or
  - Click on the IDL VM icon then browse to get to the **icesavis_ds.sav** file and press the open button.

On the Mac:

- Modify the environment variables in **run_vm_visualizer.ksh** as necessary:
  - On the Mac, you may have to change the first line from #!/usr/bin/ksh to #!/bin/ksh or wherever ksh resides on your system.
  - Change $DIR_MAIN to the directory where the icesatvis_ds.sav file resides (use "./" if invoking in current directory).
  - If you are using a Mac or if this is not your only IDL installation (e.g., if your regular IDL is too old), you will probably want to add the full path to your IDL VM bin directory on the last line that states "idl –vm=…". You will need to either do this or add the IDL VM bin directory to your $PATH environment variable (which would make this version the default when you type "idl").
    i.e. /Applications/rsi/idl/bin/idl -vm=$DIR_MAIN/icesatvis_ds.sav

- To run the IDL virtual machine version of the Data Visualizer, in the **idl_visualizer** directory type:

  $ **run_vm_visualizer.ksh**

  or type:

  $ <***path***>**/idl_visualizer/run_vm_visualizer.ksh** from any directory on the Unix system.

- Click on the IDL splash screen. Note that this may be hidden behind other windows.

3.0 Selecting Data

This GUI allows the user to visualize parameters from any of the GLAS standard data products that reside on the local machine. The user can either visualize a subset of data from all files in a data directory by pushing the "Subset Data" button or visualize specific files by pushing the "Select Specific Files" button.

The main window is shown in Figure 3-1: SCF visualizer main window.

Figure 3-1: SCF visualizer main window

Subset Data: allows the data in the directory to be subsetted by time, track, and lat/lon. The most restrictive information will be used - for example, if the user selects a time span or region and a set of tracks, he or she will only receive the subset of the tracks that are within the time span or the region. Since information is taken from all files in the directory, the more data in the directory, the longer initial access will take, possibly several minutes. The Data Management System files (files starting with BN, GR, PS, UR) need to be in the same directory as the GLA products for this option to work. These files allow the data to be quickly subsetted.

Important note about multiple data files for the same product in the same directory: The Visualizer filters data for the requested time span and geographic region from all files matching the requested products in the selected directory. The visualization software visualizes data from the most recent product file if older ones exist. Therefore, if the user wants to look at data from a specific file, he may either put the file in a separate directory and select that directory in the Visualizer (see next section), or he may use the "Select Specific Files" button on the main window to visualize a particular file.

Select Specific Files: display a list of product files available in the data directory. One file for each product may be selected and the files must correspond in time and lat/lon. The Data Management System files (files starting with BN, GR, PS, UR) do not need to exist for this option to work.

3.1Subset Data

Figure 3-2 shows the data selection window that appears after one chooses “Subset Data”. The user uses this window to define the directory where the data to be visualized are located and the data release. The user also defines which types of products to look at (any or all of GLA01-GLA15), the region of interest, the time period of interest, and specific passes of interest. The most stringent of all the criteria is used to select which files and which records of data within the data directory to visualize.

Note: This Visualizer option uses the Data Management System (BN, GR, PS, UR) files to quickly subset the data. However, since it initially accesses these files for information, it responds more quickly with fewer files in the data directory.

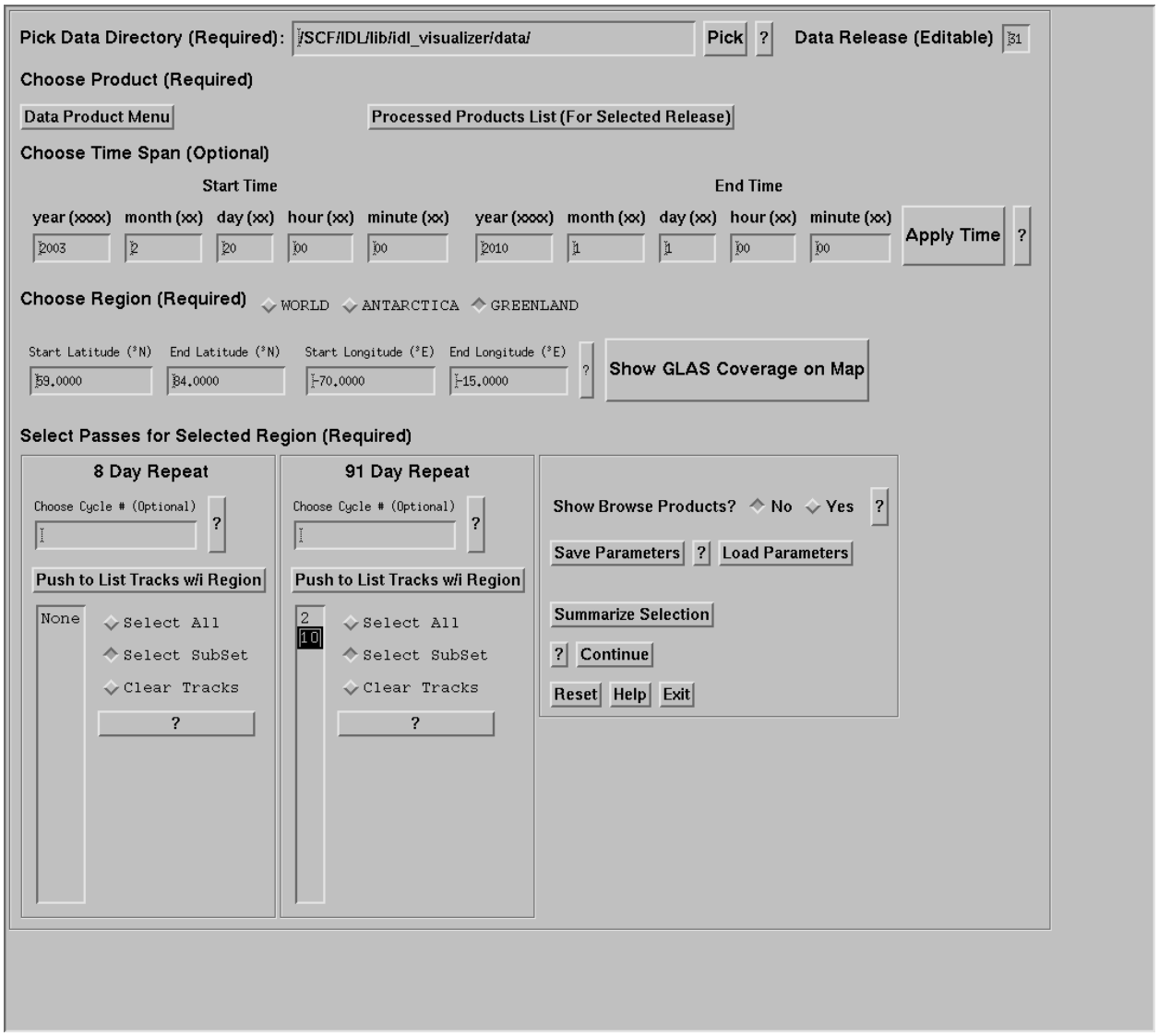

Figure 3-2: SCF visualizer data selection window

Description of request parameters:
? – Help button - The question mark buttons pop-up windows with a brief help text for the adjacent button or field. Dismiss by clicking the pop-up's File menu, then "Done with…"

Data Release – Required - This should be selected first. Enter the I-SIPS data release you want to see data for. **It is crucial that this field be correct for the data files to be visualized properly.** You will find the data release in the last 2 digits of the number segment after the GLAXX (i.e. GLA06_428_… is release 28) or in the last 2 digits of the number segment before the LXX (i.e. GLA06…_531_L2A… is release 31) depending on the naming convention. The default release is the latest one, so it is particularly important to change the release if you wish to view older data. For example, if you wish to visualize release 26 data, enter 26 in the box. Please note that you may only visualize older releases if the data are still available in the specified directory. **Only data from the release specified will be selected.**

Pick Data Directory – Required - The user can change the data directory to whatever he desires by using the pick button that will bring up a window with a directory tree to choose from. A help button describes how to use the "Pick" button to select the data directory. **The Visualizer will only look for data products in this data directory**. If there are no files in this directory with the specified release, a warning window will pop-up. **Please note that regardless of the time span, tracks, and region selected, data may only be visualized if they are available in the data directory.**

The standard IDL dialog_pickfile() function, which is used here, is unfortunately not completely intuitive. Choose each *intermediate* subdirectory in turn from the list labeled "Directories" on the left, or type directly into the "Directory" box, pushing the "Filter" button each time. The *final* subdirectory, however, should be selected from the list labeled "Files" on the right. Then push the "OK" button to dismiss the dialog and continue.

Processed Products List (For Selected Release) – Optional - Pushing this button gives a list of products for the specified release that are available in the selected directory. This is handy for determining available products before selecting them. **You must push this button if you changed the release after selecting the data directory.**

Choose Product – Required - See "Data Product Menu" section – allows users to select data products.

Chose Time Span – Optional – The user selects a start time and end time. The program will process only the passes within the time span. If the user changes the time selection, he needs to push the "**Apply Time**" button. Default is the entire ICESat mission. However, the time span is really constrained by what's available in the data directory.

Choose Region – Required - The user can select start and end latitude and longitude in either this window or the map window as a rectangle in latitude and longitude. The latitude range is from -90 to 90 North, and the longitude range is from -180 to 180 East of Greenwich. The user can press the "World", "Antarctica", or "Greenland" button to select that region. The default is the entire world. However, the region is really constrained by what's available in the data

directory. To select an even more specific region or see the selected region on a map, press the **"Show GLAS Coverage on Map"** button (below).

Show GLAS Coverage on Map – Optional - See **"Map Display"** section - allows users to select and view a selected region and display and select ground tracks within the region on a map.

Select Passes for Selected Region – Required – The program will process only selected tracks.

If tracks were already selected and loaded through the map interface, they should be highlighted in black in the track window. If nothing is highlighted, then tracks must be selected.

Passes are defined by reference orbit (8 or 91 day), cycle number, and track number.

The user must select tracks for either the 8-day or 91-day repeat track reference orbit (or both). The selection of cycles is optional. Default is all cycles for selected tracks.

To select a specific cycle, merely type it in the appropriate box. More than one cycle can be selected by separating the cycle numbers with commas (,) or dashes (-). i.e. 1,2 or 1-2.

Push to List Tracks w/i Region – **Required if tracks were not selected via the map display -** Press to display the list of tracks available for the selected region and time span, for the 8 or 91 day repeat. Note that available tracks are determined from all data in the directory and so some products may not be available for a specific pass. Clicking the "Select All" button highlights all the available tracks. Clicking the "Select Subset" button allows the user to select discrete tracks or sets of tracks within that list. To select multiple discrete tracks, hold down the Ctrl key while selecting the tracks individually with the left mouse button. To select a set of tracks hold down the shift key, use the left mouse button to sweep out the set of tracks.

Show Browse Products? – Optional **–** Browse products may be displayed only if they exist in the data directory. Select "Yes" to display**.** Default is no. The browse products are in png format.

Save Parameters – Optional - Push this button to save all the current selected parameters into a file designated by the user. This feature is very convenient when visualizing similar parameters multiple times.

Load Parameters – Optional - Push this button to load a previously saved parameter file.

Summarize Selection – Optional - Push this button to see your selected parameters before submitting them.

Continue – Required - Pushing this button submits the data for visualization. If there is not enough information to submit, an error message will be displayed that prompts for the missing information. Only when all required information is selected will the request be submitted.

Reset – Optional – This button will reset the time span, region, product, and pass selections to their default values.

Help – Optional – This button will bring up documentation on how to use this window.

Exit – Optional – Exits from the GUI so no visualization is done.

Once the request is submitted, the Visualizer determines which files and records are within the data selection criteria. If no data within the requested parameters are available, the Visualizer will exit and an error will appear in the IDL window:

No requested data available

Otherwise, groundtrack and data plots will pop-up.

3.1.1 Data Product Menu

Pushing the "**Data Product Menu**" button opens a new window, depicted in Figure 3-3, which gives a menu of GLAS products. You must select one or more products from this list.

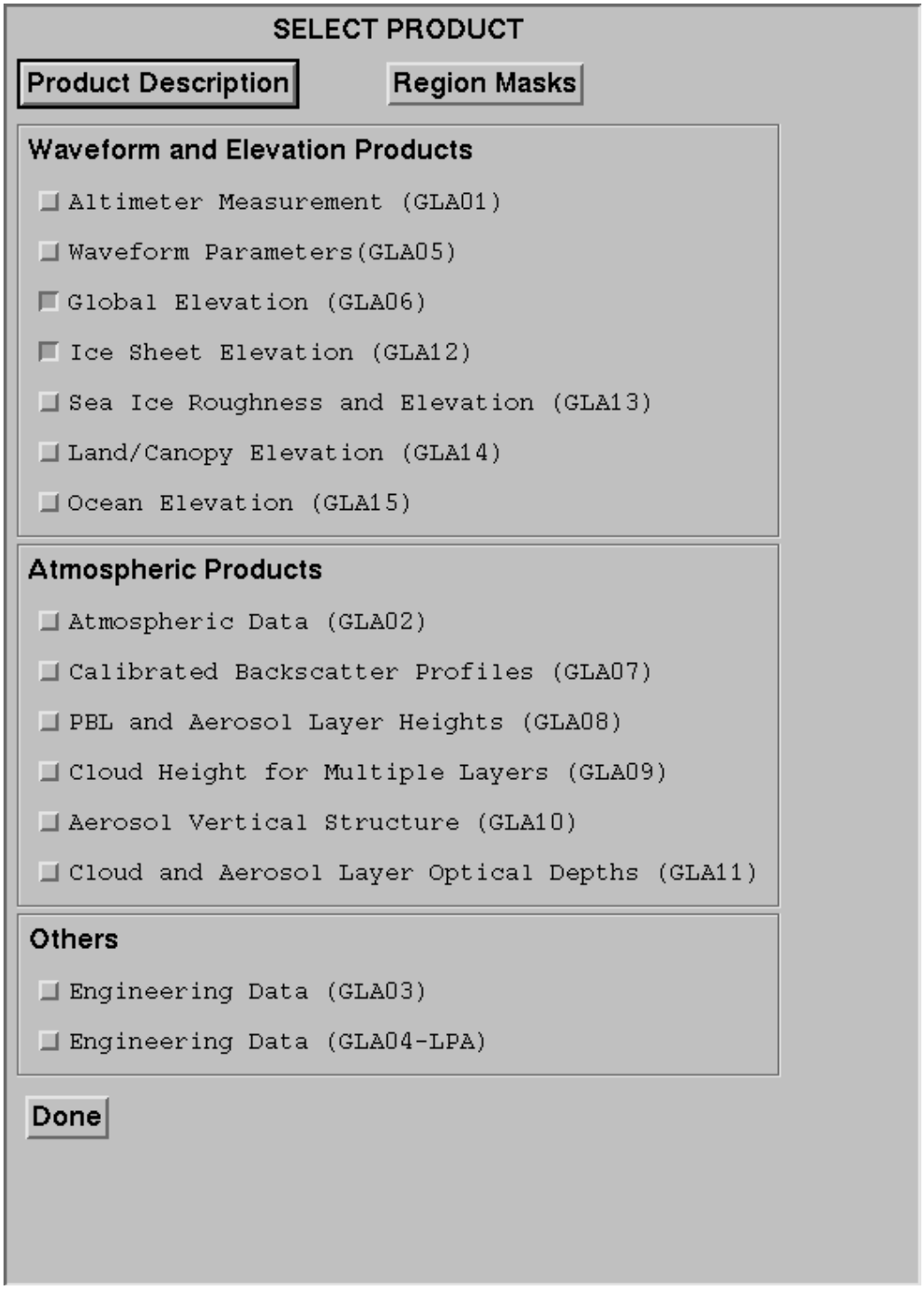

Figure 3-3: Product selection window

The products are grouped by type and if one pushes the "**Product Description**" button a short description of each product is displayed. Press the "**Region Masks**" button to display an image of the region masks. This is useful in determining whether to select GLA12, 13, 14, or 15. Press "**Done**" when your selection is complete.

NOTE: If the user selects GLA03 or 04, GLA01 will automatically be selected also. This requirement is necessary because GLA03 and 04 lack the location information required by the Visualizer. Also, GLA03 can be selected, but is not currently supported by the Visualizer. If GLA03 is selected, no data from it will be displayed.

Region Masks – A display of the region masks is shown in Figure 3-4.

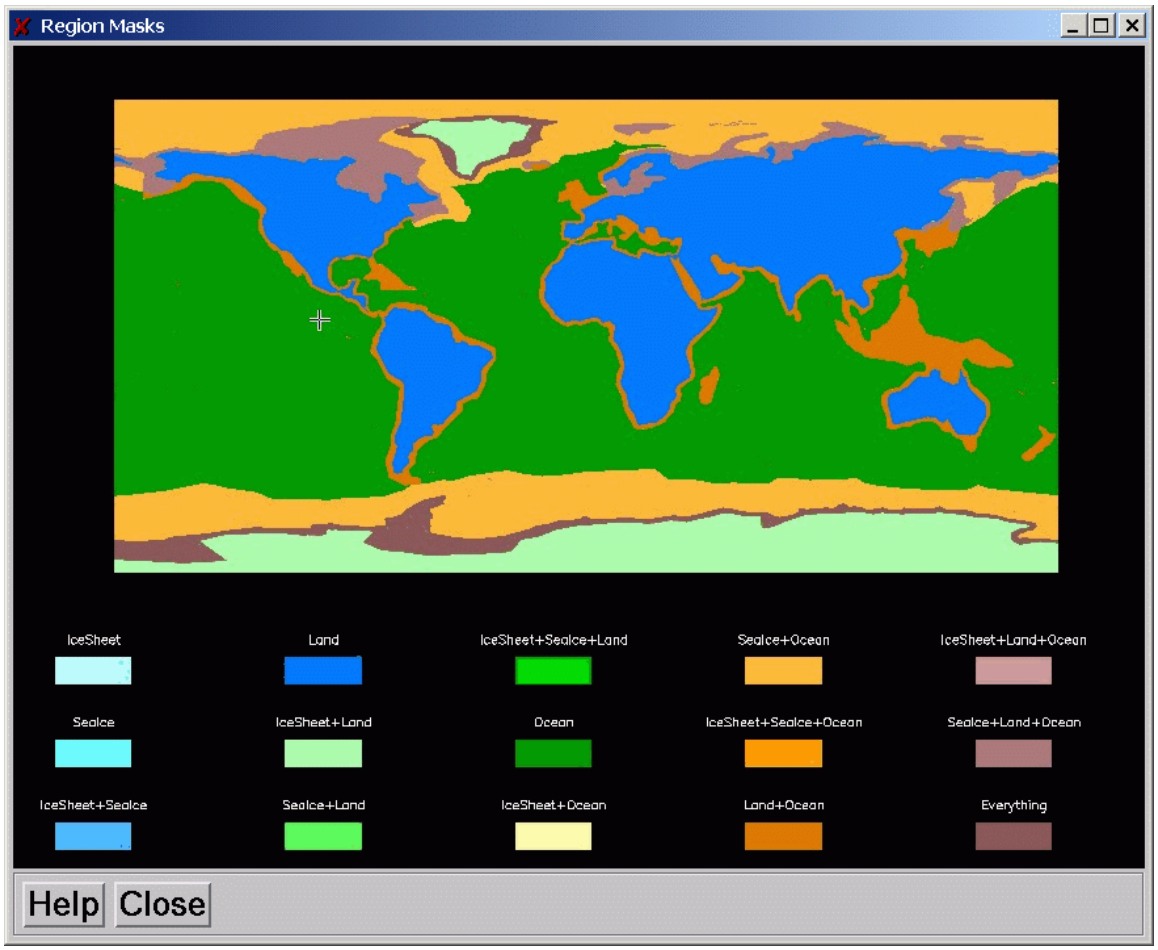

Figure 3-4: Region masks display

3.1.2 Map Display

The "**Show GLAS Coverage on Map**" button brings up the map and ground track display window shown in Figure 3-5. This is a tool to help the user select tracks over his area of interest. The user can display a region map or zoom a region and display the tracks over this region to see the coverage. Only tracks for which the user has data in his selected data directory are displayed, however they will be displayed as if data exists for the whole pass, whereas the product may only contain a small portion of the pass.

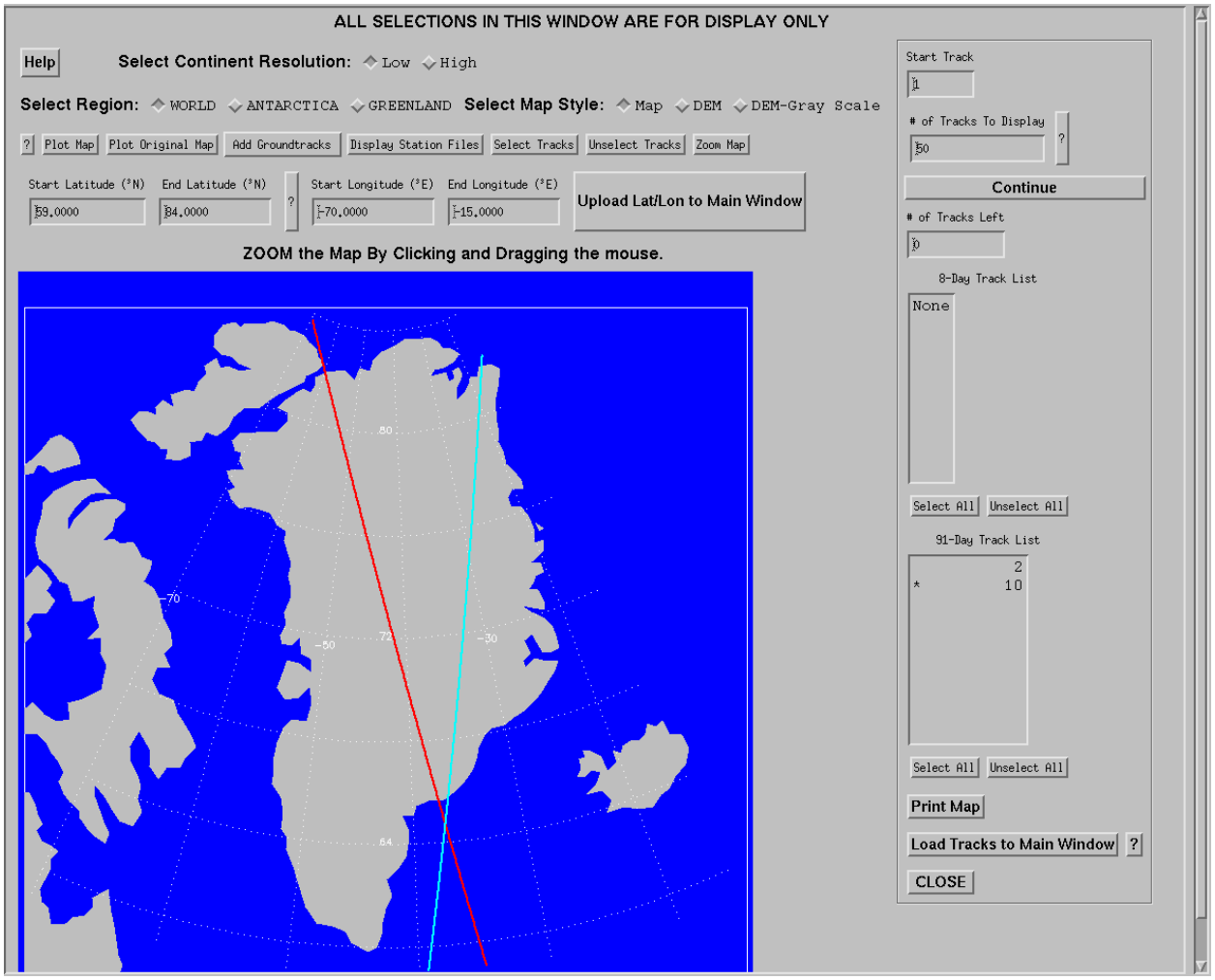

Figure 3-5: GLAS coverage on map display

Select Continent Resolution – Select low or high resolution. Default is low resolution. Press the "**Plot Map**" button after making your selection.

Select Region – If the user selected a region on the main data selection window, this map will be displayed.

If not, the user can display Greenland, Antarctica, or the whole world. Press the "**Plot Map**" button after making your selection. Further refinement of the region is accomplished by using the left mouse button to click and drag to select an area outlined in green. Clicking the "**Zoom Map**" button will then zoom that area. To get back to the original map you started from before zooming, press the "**Plot Original Map**" button. The user may also just type in the desired starting and ending latitudes and longitudes in the appropriate boxes then press the "**Plot Map**" button. To transfer these new lat/lon values to the main data selection window, the user must press the "**Upload Lat/Lon to Main Window**" button.

Select Map Style – Map is the default. Pressing the DEM button will plot a shaded-relief Digital Elevation Model instead of the continental outlines. A high resolution DEM is used: GSFC Greenland and Antarctic 5km, or USGS 30 second for all other regions. The resolution of the DEM is chosen based on the area displayed. The smaller the area, the finer the resolution will be, down to the finest resolution of the DEM. **DEM-Gray Scale** plots elevation in shades of gray. Press the "**Plot Map**" button after making your selection.

Add Ground Tracks – Press this button and select either the 8-day or 91-day repeat from the pull down menu to add ICESat ground tracks on the map display. You can only display tracks from either the 8-day or 91-day reference orbit, but not both at the same time. By default, only 50 tracks are displayed at a time. Pushing the" **Continue**" button will display the next 50 tracks. If you wish to display more or less than 50 tracks at a time just change the number in the text box. Once the next batch of tracks has been displayed, if you want to see the first batch again, you have to press the "**Add Groundtracks**" button again. A list of the displayed tracks is shown in a list box to the right of the map. Only tracks that have data in the selected data directory are displayed. (See section below, "How to Select Ground Tracks" for methods of selecting ground tracks.) After selecting tracks, the user can load them to the track list of the main data selection window by pushing the "**Load Tracks to Main Window**" button. Select "**Close**" when done to be brought back to the main data selection window.

How to Select Ground Tracks

- Unselected tracks are red on the map, and have nothing beside their numbers in the track list window.
- Selected tracks are cyan on the map and have asterisks (*) beside their numbers in the track list window.
- For reference, selected tracks are saved among maps!

There are several ways to select tracks:

Select tracks from list – In the track list window, click on a track number with the left mouse button. Unselect the track number by re-clicking on it.

- Click the "**Select All**" button under the track list window to select all the tracks in the track list.
- Click the "**Unselect All**" button under the track list window to unselect all the tracks in the track list.

Select tracks from map – In the map window, click on a track with the left mouse button. This may take some practice! Since the track lines on the map are actually interpolations of data points, sometimes clicking on a track will not work, if you are not hitting the actual data point. Unselect the track by re-clicking on it.

Select tracks from map within selected area - In the map window, select an area by clicking and dragging with the left mouse button. The selected area will be green on the map. If it is not correct, reselect it. Once the area is selected, there are three things you can do:

- Click the "**Select Tracks**" button to select all the tracks within the selected area.
- Click the "**Unselect Tracks**" button to unselect all the tracks within the selected area.
- Click the "**Zoom Map**" button to zoom the selected area on the map.

When you're done with an area, you may select another area. If you're having trouble clicking on a track (especially in a zoomed region), select an area around the track then click the "**Select Tracks**" or "**Unselect Tracks**" button.

Remember that to retrieve data for the selected tracks, you must load them to the main data selection window by pushing the "**Load Tracks to Main Window**" button.

Display Station Files – Push the "**Display Station Files**" button to bring up a window that allows the user to select an existing user location file or Target of Opportunity (TOO) file. User location files should be ASCII text with the following structure:

- The first line is 1 or 0:
  1: Connect the points
  0: Don't connect the points (plotted as asterisks).
- The second line is the number of location pairs (latitude, longitude) that follow.
- Subsequent lines are the location pairs: north latitude, east longitude (-180 to 180).

- If station names are included after the lat/lon pairs, they will be displayed next to the plotted points on the map. You can mix lines with and without station names.

  Example:

  0
  3
  64, -60, Station A
  75, -50, Station B
  80, -20, Station C

The automatically generated TOO files can also be displayed. TOOs will normally plot as thick cyan lines. However, they may cover a very short range and not be easily seen until zoomed in.

Example of a TOO file: 2006-06-11_stations.txt_chk:
Haughton_NWT,2006-06-11,07:52,75.867,74.867,270.96315,269.77685,1

Gr_030515_01,2006-06-11,15:47,75.96641,79.47025,300.61213,294.54386,1

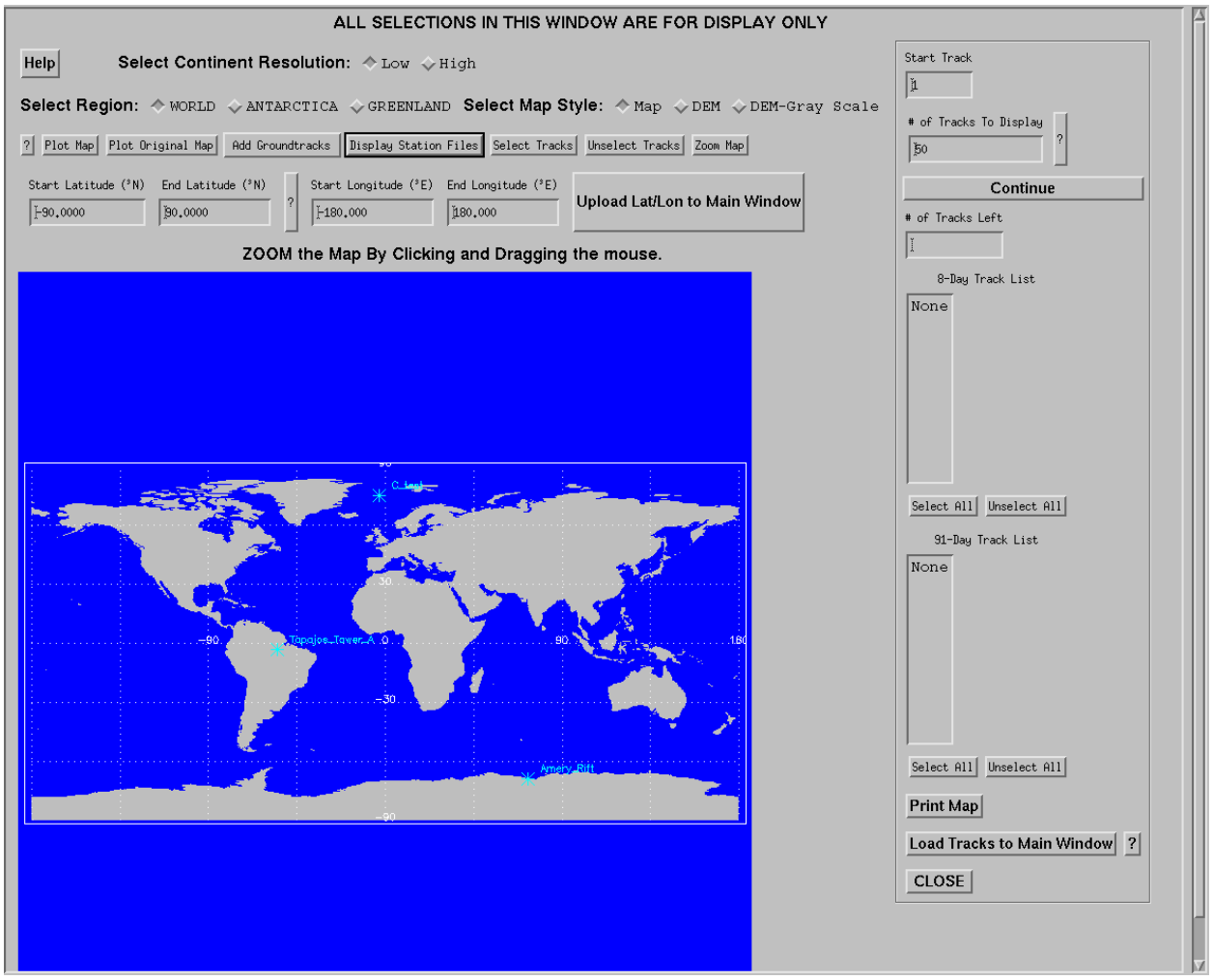

Figure 3-6: Displaying station files

Print Map – Pressing this button creates a PostScript file of the map. "**Create File**" must be pressed to create the file. Subsequent plots will overwrite the first one unless a different file name is created. Default file name is idl.ps.

Load Tracks to Main Window – Loads selected tracks to main data selection window. Only the selected (*) tracks listed in the track window are loaded. If you need to press the "**Continue**" button to select more tracks, then you need to load those tracks as well.

Close - Upon closing the map display window, the user returns to the main data selection window.

3.2Select Specific Files

This option allows specific files to be visualized. If this button is selected, a window will appear allowing the user to input specific product files, one per product type, as shown in **Error! Reference source not found.** Unlike the Subset Data option, the Database Management System files do not need to exist for this option to work. If the unique record file (UR) is available it will be used; if it is missing, it will be created automatically. Care should be taken to only select files that have data with corresponding time spans. Also, be sure that you specify the correct Data Release for your data.

When you have selected all of the product files desired, press the "**Display Data**" button to continue.

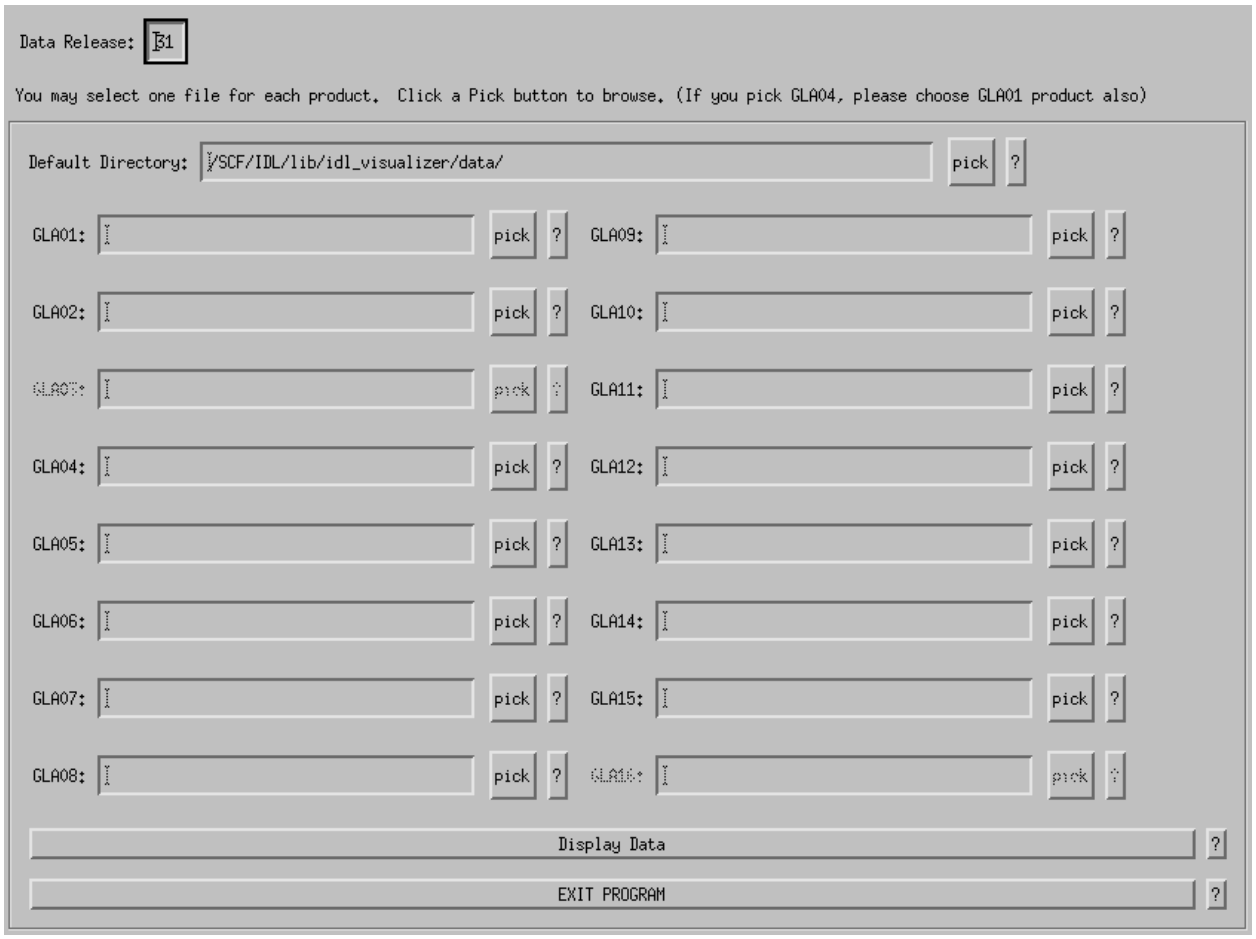

Figure 3-7: Select Specific Files window

Note: GLA04 files must be accompanied by another product, because GLA04 lacks the location information required by some parts of the Visualizer. If you select only a GLA04 file, you will receive a pop-up warning to select another product also. GLA03 files are not currently supported by the Visualizer.

4.0 Visualizing Data

4.1 Viewing Browse Products

If the "**Show Browse Products**" option was selected and browse products are available in the data directory, a Browse Product Selection window pops-up (Figure 4-1). This window lists the browse product files that correspond to the data products being visualized.

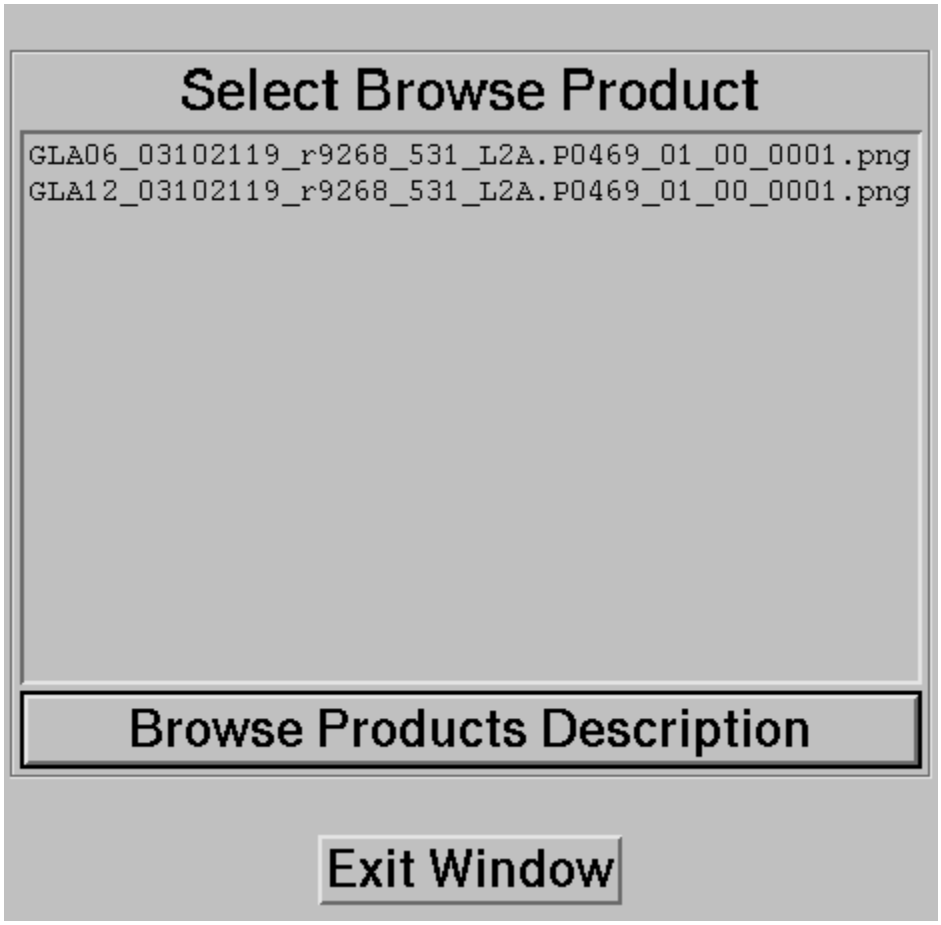

Figure 4-1: Browse Product Selection window

Selecting a file in the list will display the browse product. Pressing the "**Browse Product Description**" button gives descriptions of the different browse products. Press "**Exit Window**" to exit the browse product selection window.

An example of a GLA06 browse product display is in Figure 4-2.

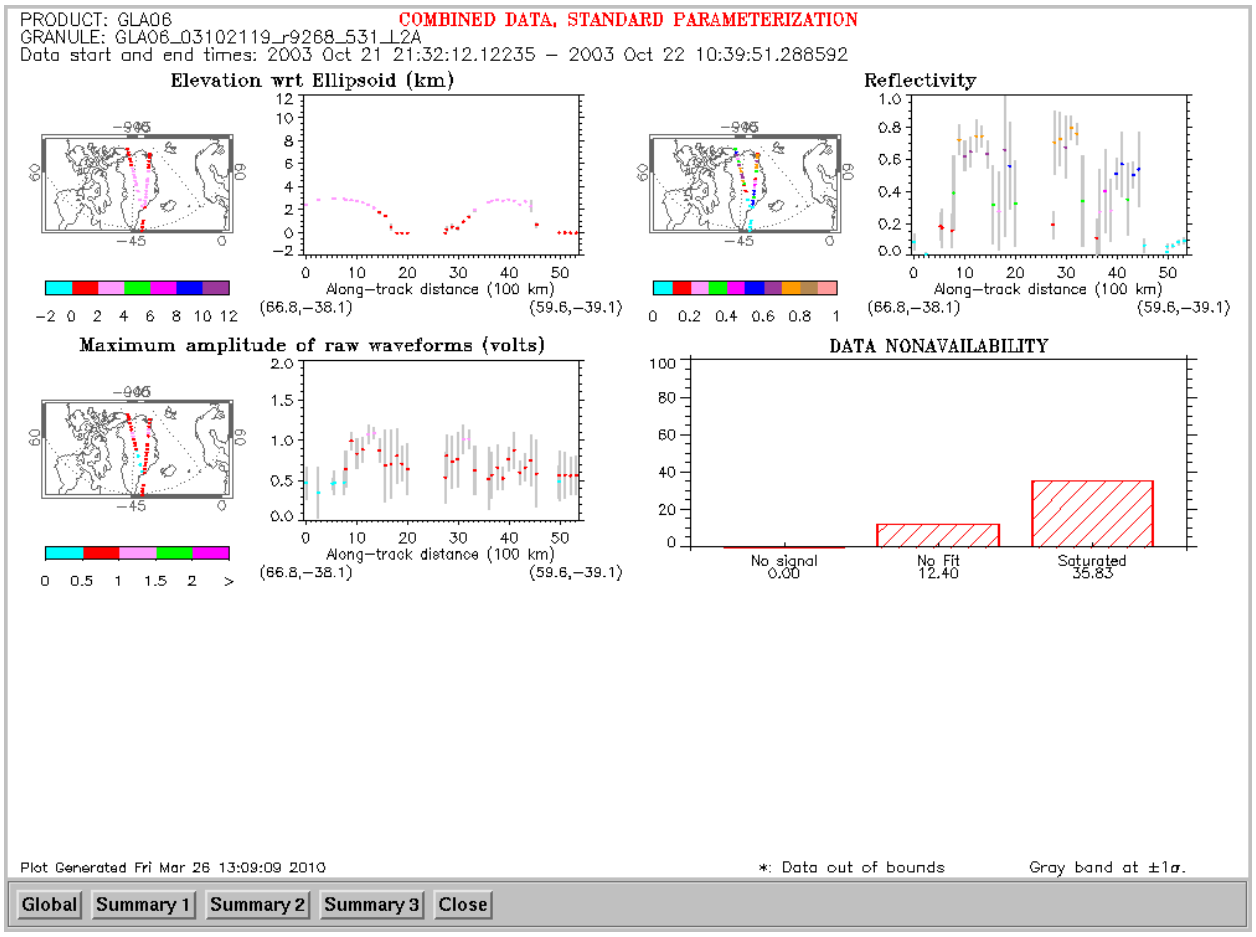

Figure 4-2: GLA06 browse product, Global page

4.2 Pass Selection Windows

After data criteria are submitted, the following windows appear to give you a snap shot of the data you have selected. If any of GLA01, GLA05, GLA06, or GLA12 – GLA15 products are chosen then a set of thumbnails (one for each pass) of decimated elevation profiles is displayed, as in Figure 4-3. (GLA01 profiles are calculated estimates, and are very inaccurate.)

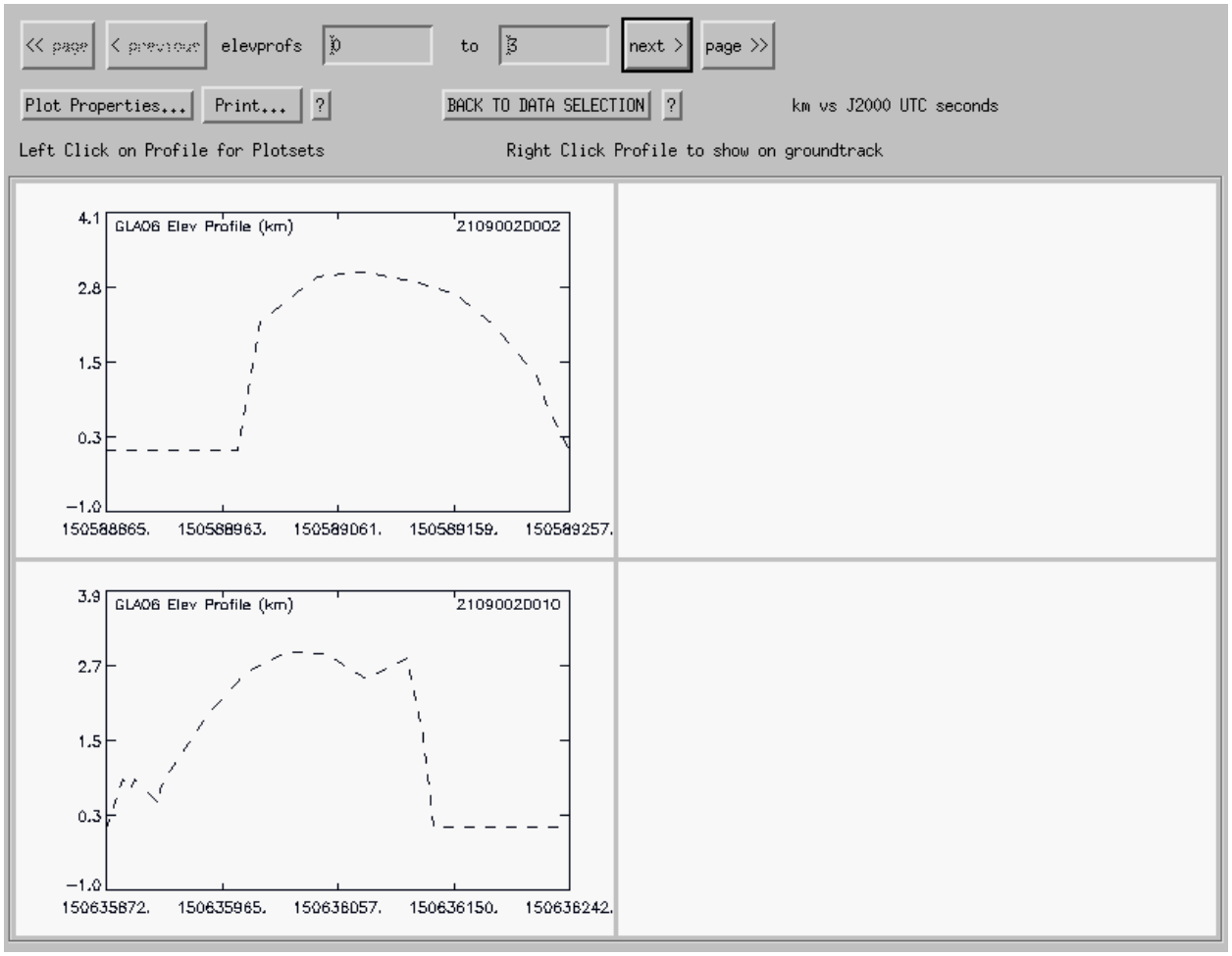

Figure 4-3: Decimated elevation profiles of data selected

If GLA02 or GLA07 is selected, then a set of thumbnails (one for each pass) of images created from the backscatter profiles is displayed as shown in Figure 4-4. These images are created from a decimated selection of the data and only give an idea of what is available. If GLA08-11 were selected without GLA02 or 07, profile images are not available; a similar window is displayed, but the individual thumbnails only show the pass ID.

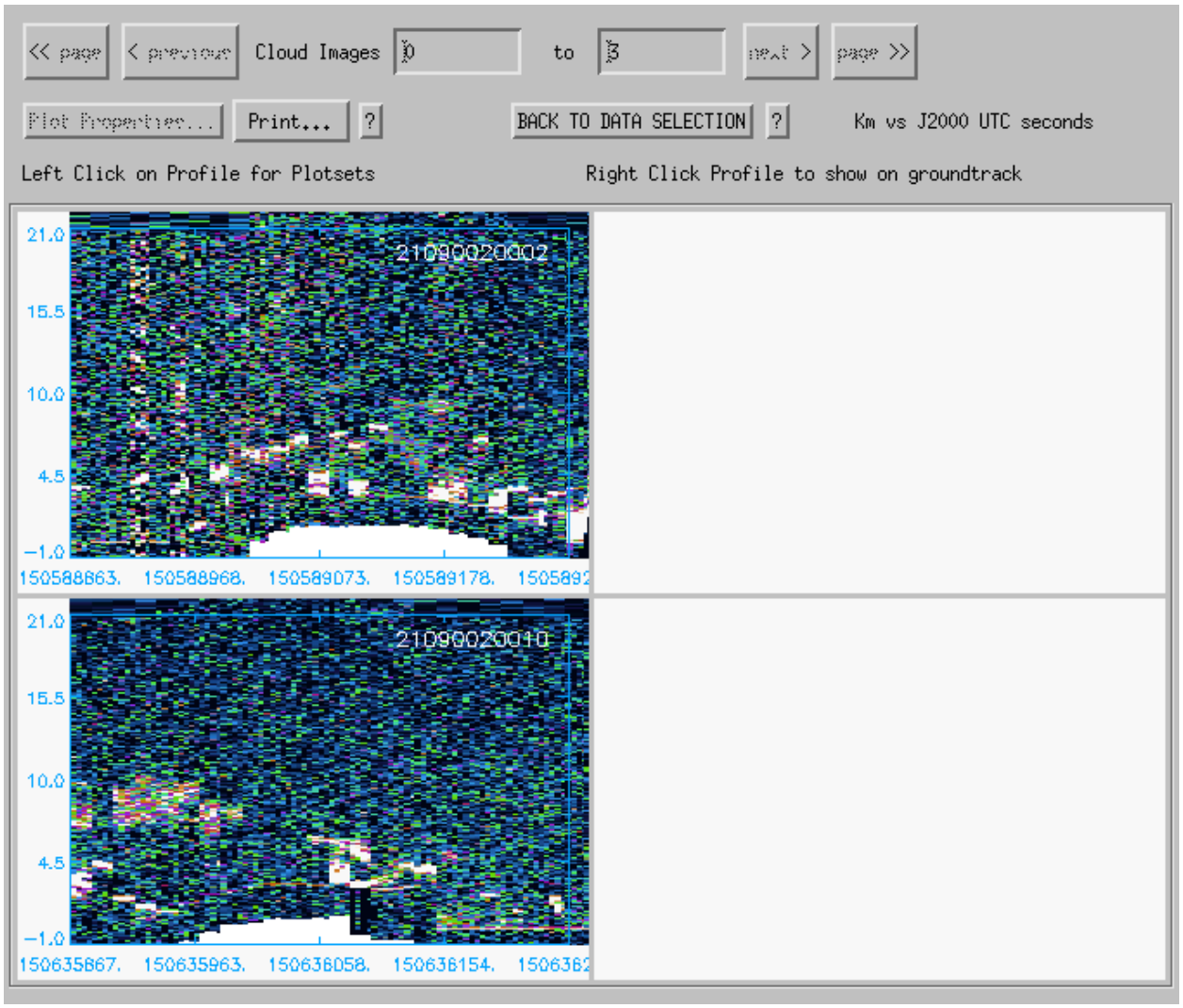

Figure 4-4: Decimated backscatter images of data selected

Use these decimated profiles to select the pass to visualize. Right-clicking on one of the backscatter images or elevation profiles will highlight that pass on the ground track window. If more than four passes are present in the selected data, then pushing the "**next**" and "**previous**" buttons show the additional passes. The "**<<page**" and "**page>>**" buttons skip backward and forward by four passes. To continue, left-click on the backscatter image or elevation profile of the pass you want to view. You can view multiple passes simultaneously, but there is no communication between the visualizations (and it's easy to get the windows mixed up). The "**Exit This Window**", "**Back to Data Selection**", or "**Return to GLAS Manual Data Set Selector**" button terminates the child visualizations and returns to the Data Selection window (Figure 3-2) or the Select Specific Files window (Figure 3-7).

If the files were selected in "Select Specific Files" mode, the product files may cover large time spans (up to 14 revs). Therefore the total time span of all files selected is artificially divided every 5800 seconds (approx. one rev), with each piece treated as if it were a separate "pass", and

the pass ID is appended with an underscore and the piece number. Actual pass information is not available to the visualizer, so substitute pass identifiers are derived from the file name, and thus may not be meaningful. Please note that the artificial division every 5800 seconds sometimes results in "passes" that have wide gaps, or that include a small piece of the next pass.

Most of the windows have "**Print…**" buttons, allowing PostScript files to be created for printing. However, the user must be sure to specify a directory for which they have write privileges for this feature so work, since the PostScript files are created there; the default is the current directory. It is possible to add more than one plot to a PostScript file; be sure to click on the "**Close PS File**" option when you have completed a file, otherwise it will not be properly terminated and may be unusable. Adding further plots to a file that has already been closed will overwrite the previous ones.

The PostScript files plot all text in the PostScript Helvetica font with a unit character size of 12 points (ie, when charsize=1.0), and lines are plotted with a unit (thickness=1.0) line width of 0.5 point (1 pt = 1/72"). These comply with the AGU standards for manuscript figures. The user can scale both character sizes and line widths using the Plot Properties (axis title/tick label sizes, curve label/annotation sizes, and axis line widths) and Curve Properties dialogs (individual curve widths). Keep in mind that text will look very different on your screen and in PostScript, relative to the size of the plot. IDL is not WYSIWYG! Be prepared to make test files and iterate. IDL always plots the main plot title at 125% of the axis title size. Also, when printing the 20-pane thumbnail windows (waveforms, lidar profiles, and LPA images), IDL will automatically reduce the axis title and tick labels by 50% (ITTVIS considers this to be a "feature").

The **Groundtracks Window** (Figure 4-5 and Figure 4-6) displays a continental or Digital Elevation Model (DEM) map with all selected ground tracks (blue); the track of the current pass-selection elevation or LIDAR profile (red); track section shown in a zoomed series plotset (cyan); and a diamond-shaped marker showing the location of the series cursor, the current waveform, or current lidar profile, if active. The window also shows the REQ file, the data file of the current elevation or LIDAR profile, and the pass ID of the selected profile. "**World**", "**Antarctica**", and "**Greenland**" reset the geographic region to these respective areas. The "**Map**" and "**DEM**" buttons toggle between the two map styles. The user can change the geographic region displayed by clicking and dragging the mouse (note that this always follows latitude/longitude lines, even on polar maps), by choosing one of the predefined region buttons, or by manually entering latitude/longitude ranges. After selecting a new region or map style, click "**Replot Map**" to draw the new map. The "**Clear Map**" button removes the zoomed track section, location marker, and user locations. "**Disable/Enable Zoom**" toggles whether the map can be zoomed. (*Tip:* Sometimes the mouse will become locked out of the map plot, preventing zooming. This can usually be fixed by toggling the Disable/Enable Zoom button a couple times.)

"**Select User File to Display Locs on the Map**" lets the user add either their own file of locations (stations) or paths, or a Target of Opportunity (TOO) file, to the map. Any number of user location and TOO files can be added; all points will be shown (until cleared with "Clear Map"). User location files should be ASCII text with the following structure:

- The first line is 1 or 0:
  1: Connect the points
  0: Don't connect the points (plotted as asterisks).
- The second line is the number of location pairs (latitude, longitude) that follow.
- Subsequent lines are the location pairs: north latitude, east longitude (-180 to 180).

- If station names are included after the lat/lon pairs, they will be displayed next to the plotted points on the map. You can mix lines with and without station names.

  Example:

  0
  3
  64, -60, Station A
  75, -50, Station B
  80, -20, Station C

There is a sample user location file in **<*path*>/visualizer_<*date*>/stations/test_stations.txt**.

TOOs will normally plot as thick cyan lines. However, they may cover a very short range and not be easily seen until zoomed in.

Note: When displaying the groundtracks on a DEM map, IDL actually creates two images: first the unprojected base map, then the projected map with the groundtracks. On the screen, the first image is not visible as the second overwrites it; but in the PostScript file, both images are present. To avoid having two images in the PS file, the user is given the option to delete and reopen the PS file before the DEM map with the projections and groundtracks are created. This is a good option if the PS file doesn't have other images that the user saved previously; but if it does, they will be lost.

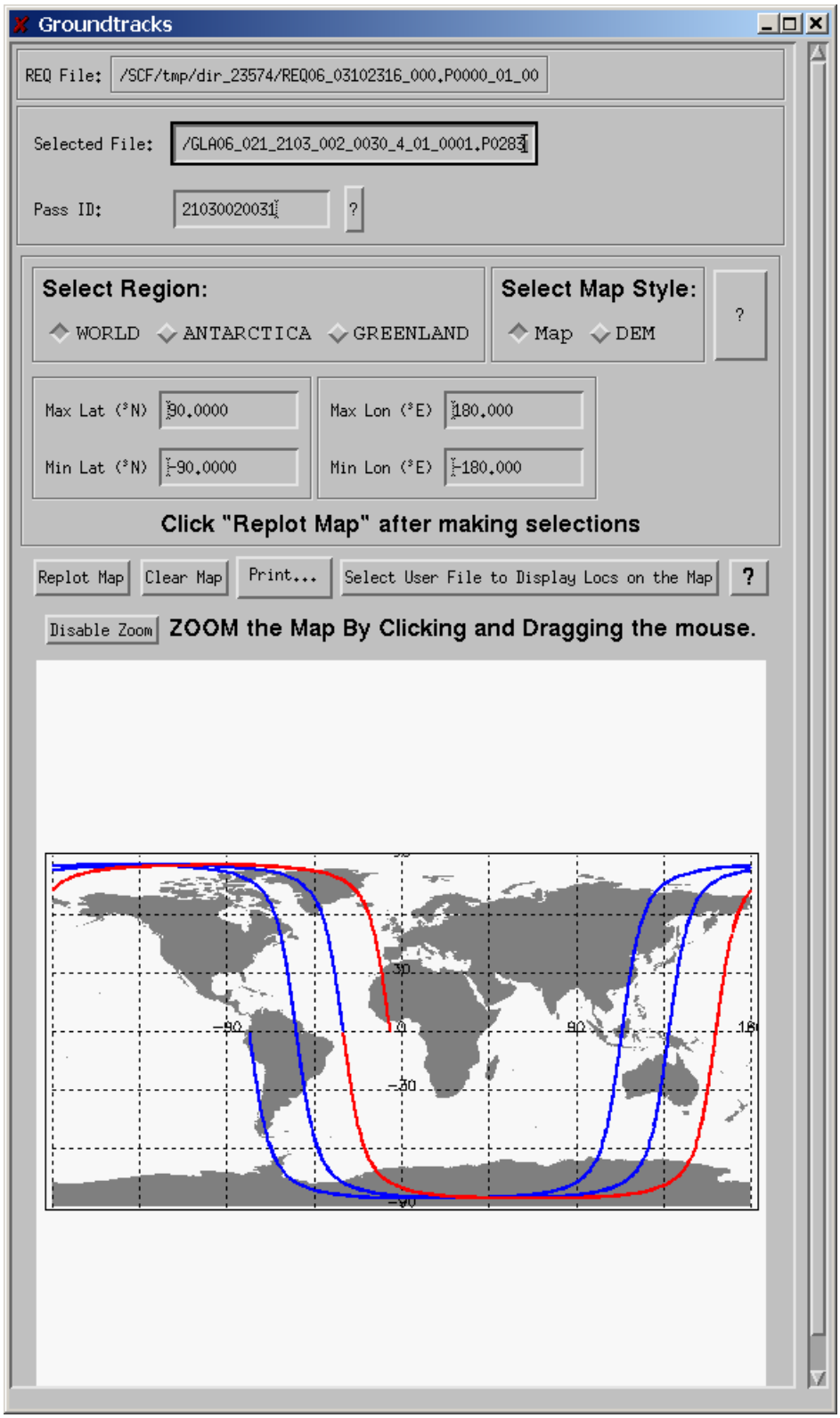

Figure 4-5: Ground tracks of data.

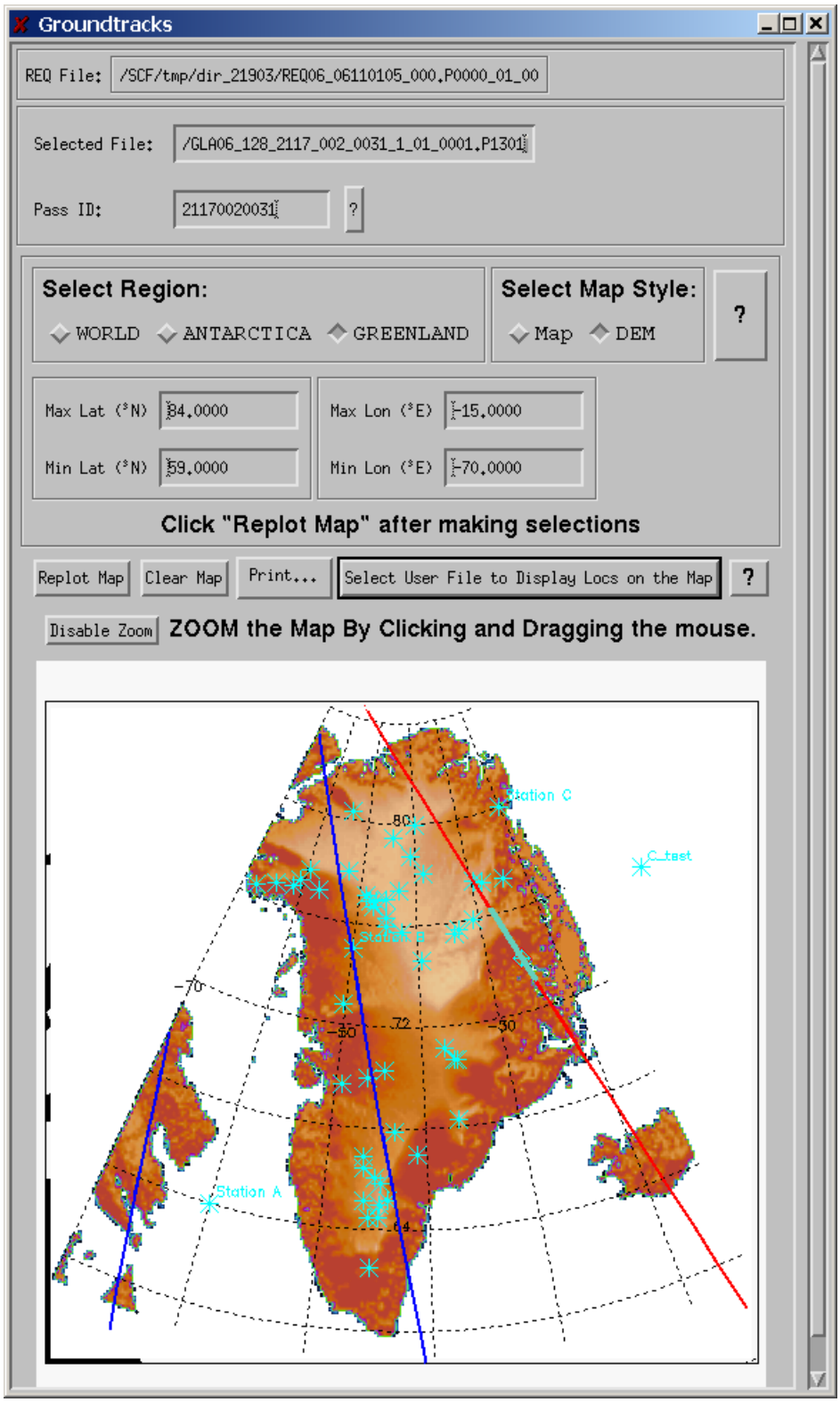

Figure 4-6: Ground track plot (Digital Elevation Model style), showing selected tracks (blue), current track (red), section covered by a zoomed plotset (aqua), location marker (green diamond), and user-supplied stations (cyan asterisks), some with station names.

The user may select one pass by left-clicking on one of the elevation or LIDAR thumbnails. The corresponding ground track will be highlighted and the plot set selection window (Figure 4-7) will appear.

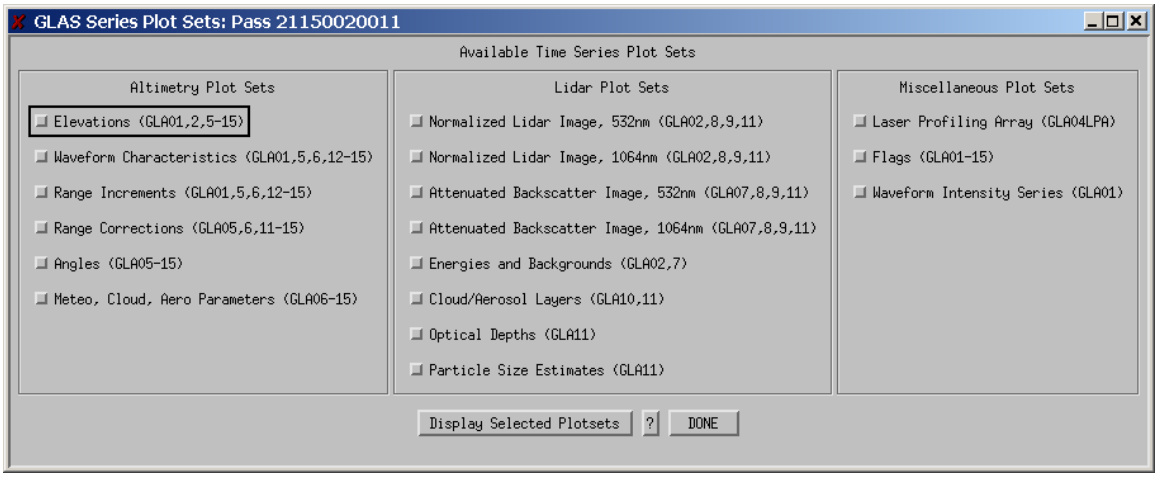

Figure 4-7: Plot set selection window

Only the plot set buttons applicable to products that the user has selected will be sensitive. Select any or all of the highlighted plot sets to view time-series of specific parameters from the products by selecting the individual plot set and then pushing the "**Display Selected Plotsets**" button. Pushing "Display Selected Plotsets" again will add any plotsets selected in the interim and remove those that have been deselected, but will not launch multiple instances of the same plotsets. "**DONE**" terminates the child visualizations and returns to the pass selection windows.

4.3 Viewing Data Curves

4.3.1 Altimetry Plotsets

In the elevation plot set shown in Figure 4-8, which is typical of the time-series plotsets, the surface elevation, DEM, and geoid from the GLA06 product for the pass selected are shown in the upper plot. The plotset type and the total range in unique indices and time are across the top of the window. On the plot itself, by default the plot title gives the data's starting UTC date and time, ending time, and the pass ID string. Some plotsets automatically show only the first shot of each second until zoomed in sufficiently; this is indicated by the "(1Hz)" notation. In the upper right, annotations "Start" and "End" give the latitude and longitude of the endpoints of the displayed section. "NaN" indicates that the location at that endpoint was not valid. The names of the curves plotted are listed in the upper left, typically with units and GLA product number. Many of these may be changed with the Curve Properties or Plot Properties buttons.

The X axis of time-series plots is generally in J2000 UTC seconds (seconds since noon, Jan. 1, 2000); this is a proxy for distance along the track. Beginning with the 200909.0 release, by default the time-series X-axis ticks are labeled with the full time only on the first tick, and offsets from that time on subsequent ticks. This is referred to as "Delta Ticks"-style labeling and helps to keep tick labels from overlapping unreadably. You can revert to standard tick labeling, or use delta tick labeling for any other axis, via the Plot Properties dialog. Y axis units differ between individual curves, so by default are shown as part of the label for each curve.

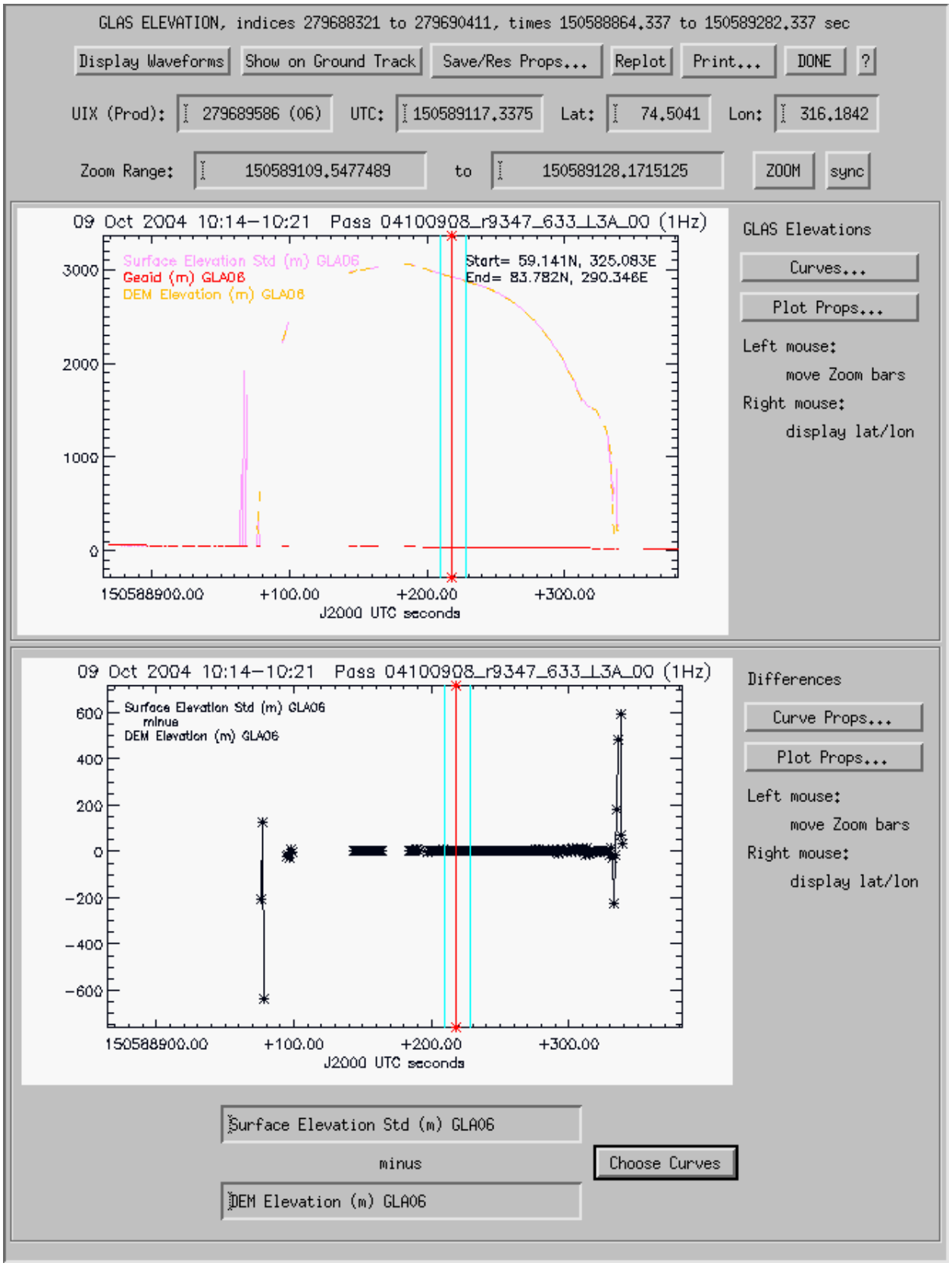
GLAS ELEVATION, indices 279688321 to 279690411, times 150588864.337 to 150589282.337 sec
Display Waveforms
Show on Ground Track
Save/Res Props...
Replot
Print...
DONE
?
UIX (Prod):
279689586 (06)
UTC:
150589117.3375
Lat:
74.5041
Lon:
316.1842
Zoom Range:
150589109.5477489
to
150589128.1715125
ZOOM
sync
09 Oct 2004 10:14-10:21 Pass 04100908_r9347_633_L3A_00 (1Hz)
Surface Elevation Std (m) GLA06
Geoid (m) GLA06
DEM Elevation (m) GLA06
Start= 59.141N, 325.083E
End= 83.782N, 290.346E
3000
2000
1000
0
150588900.00
+100.00
+200.00
+300.00
J2000 UTC seconds
GLAS Elevations
Curves...
Plot Props...
Left mouse:
move Zoom bars
Right mouse:
display lat/lon
09 Oct 2004 10:14-10:21 Pass 04100908_r9347_633_L3A_00 (1Hz)
Surface Elevation Std (m) GLA06
minus
DEM Elevation (m) GLA06
600
400
200
0
-200
-400
-600
150588900.00
+100.00
+200.00
+300.00
J2000 UTC seconds
Differences
Curve Props...
Plot Props...
Left mouse:
move Zoom bars
Right mouse:
display lat/lon
Surface Elevation Std (m) GLA06
minus
DEM Elevation (m) GLA06
Choose Curves

Figure 4-8: Elevation plotset, top shows time-series of specific parameters, bottom shows differences between two selected parameters. The vertical cyan bars indicate the range that a zoomed plot will cover (exact values are shown in the "Zoom Range" boxes), and the vertical red bar indicates which waveforms will be shown when "Display Waveforms" is clicked. The record (unique index, with product used), time, and ground location of the red bar are shown in the "UIX", "UTC", "Lat", and "Lon" boxes, and is indicated by a marker on the groundtracks plot (see Figure 4-6). "(1Hz)" indicates that only the first shot of each second is plotted.

Difference Plots – The lower plot can show differences between any two curves available in this plot set or between a curve and a null curve. Use the "**Choose Curves**" button to select the curves to difference (Figure 4-9). Select the first curve by pressing the button under "1" next to the curve and select the second curve by pressing the button under "2" next to the curve. Press the "**Apply selection**" button to display the difference curve. Press the "**Cancel pending**" button to cancel the selections. Press the "**Dismiss window**" button to exit the window. In Figure 4-8, the difference is between the measured surface elevation and the DEM on GLA06. Not all plot sets include a difference plot.

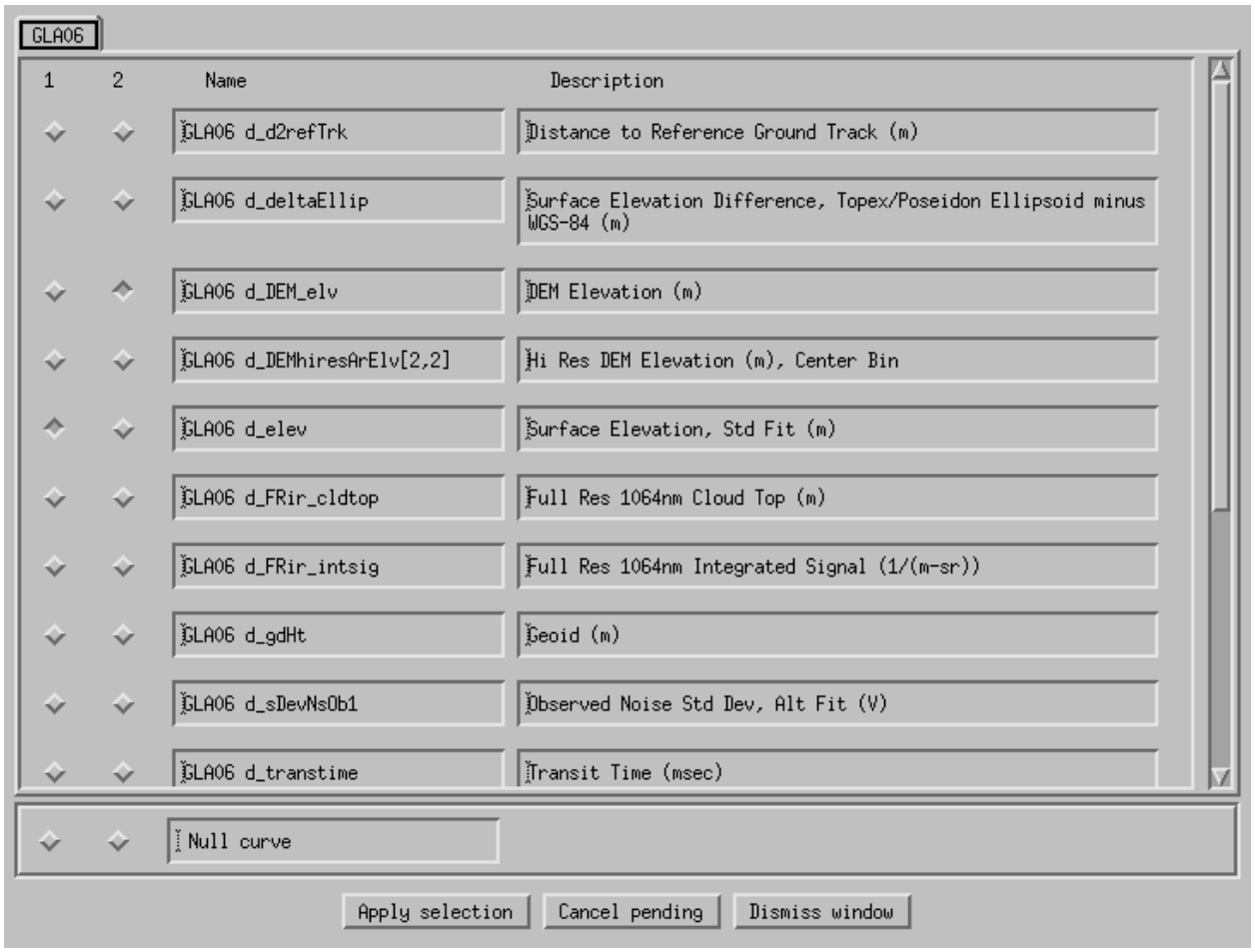

Figure 4-9: Difference plot curve menu

Zooming (left click/drag) – The turquoise bars on each edge of the plot are **zoom bars**. Click on these bars and drag them left or right to define the zoom range, then push the "**Zoom"** button

and a new plot set with only the data in that range will appear as shown in Figure 4-10. (Vertical zooming is not supported, but the vertical axis range can be changed via the "Plot Properties" button.) If you cannot see a zoom bar, click anywhere within the window and the closest zoom bar will appear which you can then drag to the desired location. If only one bar is visible, click closer to the edge of the plot on the appropriate side to select the other. The current locations of the zoom bars are shown in the Zoom Range boxes, which are automatically updated when you move the bars with the mouse. A "<" or a ">" next to a zoom range box indicates that the corresponding bar is left or right of the current range of the plot, respectively. You can also enter a zoom range directly into these boxes, then click the "**Sync**" button to reposition the bars to these locations. Moving or syncing the zoom bars will update the zoom ranges and bars in all other series belonging to the same plotset selection window.

Red Cursor (right click) – Right-clicking on a time-series plot positions a **red cursor** (vertical line). The unique index (followed in parentheses by the product where this information was found), time (in J2000 seconds), and location of the first shot in the record where the line is positioned are shown in the boxes marked "UIX (prod)", "UTC", "Lat", and "Lon". "NaN" indicates the first shot did not have a valid location. If the cursor was positioned in a gap in the data, the information will be shown for the closest record found. If a thumbnail window is shown (eg., Figure 4-15), it will be positioned to the records corresponding to the displayed waveforms or lidar thumbnails. The geographic location of the cursor will be shown in the Groundtracks plot with a diamond-shaped, cyan marker.

Display Waveforms button – Right clicking (to set the red cursor) on any portion of the time-series profile in an altimetry plot set and then clicking on "Display Waveforms" will display the corresponding waveforms if GLA01 has been selected, beginning at the location of the red vertical cursor. See Section Waveform Thumbnails.

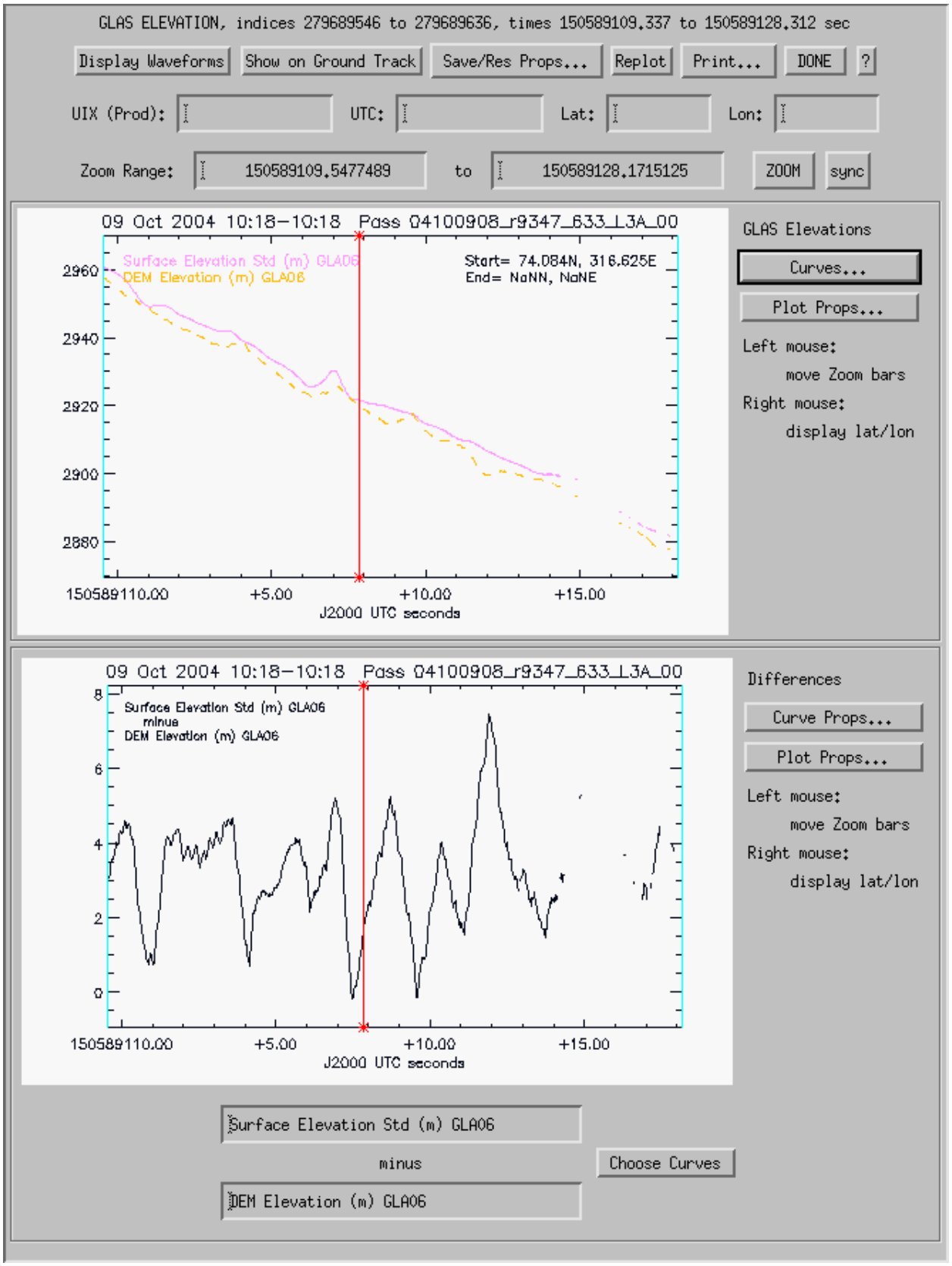
GLAS ELEVATION, indices 279689546 to 279689636, times 150589109.337 to 150589128.312 sec
Display Waveforms
Show on Ground Track
Save/Res Props...
Replot
Print...
DONE
?
UIX (Prod):
UTC:
Lat:
Lon:
Zoom Range:
150589109.5477489
to
150589128.1715125
ZOOM
sync
09 Oct 2004 10:18-10:18 Pass 04100908_r9347_633_L3A_00
Surface Elevation Std (m) GLA06
DEM Elevation (m) GLA06
Start= 74.084N, 316.625E
End= NaNN, NaNE
2960
2940
2920
2900
2880
150589110.00
+5.00
+10.00
+15.00
J2000 UTC seconds
GLAS Elevations
Curves...
Plot Props...
Left mouse:
move Zoom bars
Right mouse:
display lat/lon
09 Oct 2004 10:18-10:18 Pass 04100908_r9347_633_L3A_00
Surface Elevation Std (m) GLA06
minus
DEM Elevation (m) GLA06
8
6
4
2
0
150589110.00
+5.00
+10.00
+15.00
J2000 UTC seconds
Differences
Curve Props...
Plot Props...
Left mouse:
move Zoom bars
Right mouse:
display lat/lon
Surface Elevation Std (m) GLA06
minus
DEM Elevation (m) GLA06
Choose Curves

Figure 4-10: Zoomed elevation plotset, top shows time-series of specific parameters, bottom shows differences between two selected parameters. The data is plotted at the full 40Hz rate. Gaps are due to missing data.

Show on Ground Track button – Pushing the "**Show on Ground Track**" button will highlight on the groundtrack window (Figure 4-6) that portion of the pass currently shown in the series plot, in cyan with a diamond-shaped marker at the location of the red cursor. This is drawn using the actual, full rate data from the product, and so will have discontinuities where there are gaps in the data, and may not lie precisely on the nominal track path.

Save/Res Props…button -- The "**Save/Res Props…**" button lets you save the current plot and curve properties, including which curves are plotted, to a file, or restore saved properties from a file. Properties for both the data and difference plots are saved, but the selection of curves differenced is not (we plan to add this in a future release). You can only restore properties to a plot of the same type. When saving properties, be sure to specify a directory for which you have write permission; the default is the one from which you launched the visualizer. ***Note:*** The X-axis range is no longer included in the properties that are saved; it was considered to be too confusing when applying saved properties to a different region or pass.

Replot button – This button just redraws the plots.

Print…button -- The "**Print…**" menu allows one to create a PostScript file of the plot. There are buttons for making a plot of the data (series) window only, or of both the data and difference windows. Be sure to use the "**Close PS File**" button when finished! Series plots are displayed with a 5:3 (x:y) aspect ratio; to maintain this, in the PostScript setup dialog specify X and Y sizes in this ratio if plotting only the data window, or 5:6 for both. Note that if the user attempts to create either the PostScript or ASCII file in a directory that they do not have write permission to (the default is the directory from which the visualizer was run), the visualizer may crash.

DONE button – Pushing the "**Done**" button will close the window.

Curves button – The "**Curves**" button brings up a window of curves available for this plot (Figure 4-11). Curves are listed in alphabetical order with the product name shown first. Curves for different products are listed separately under tabbed curve menus. Therefore, to see d_elev from GLA05 and GLA06, you must select d_elev from both the GLA05 and GLA06 curve menus. To select a curve, press the button under "**Show**". Multiple curves may be displayed at the same time. Press the "**Apply Properties**" button to display the curves. If you do not wish to see the curves currently displayed, either unselect the curve buttons under "**Show**" or press the "**Hide all curves**" button. Then press the "**Apply properties**" button. If you have selected curves to display then decide otherwise, press the "**Cancel pending**" button. To exit the curve window, press the "**Dismiss window**" button.

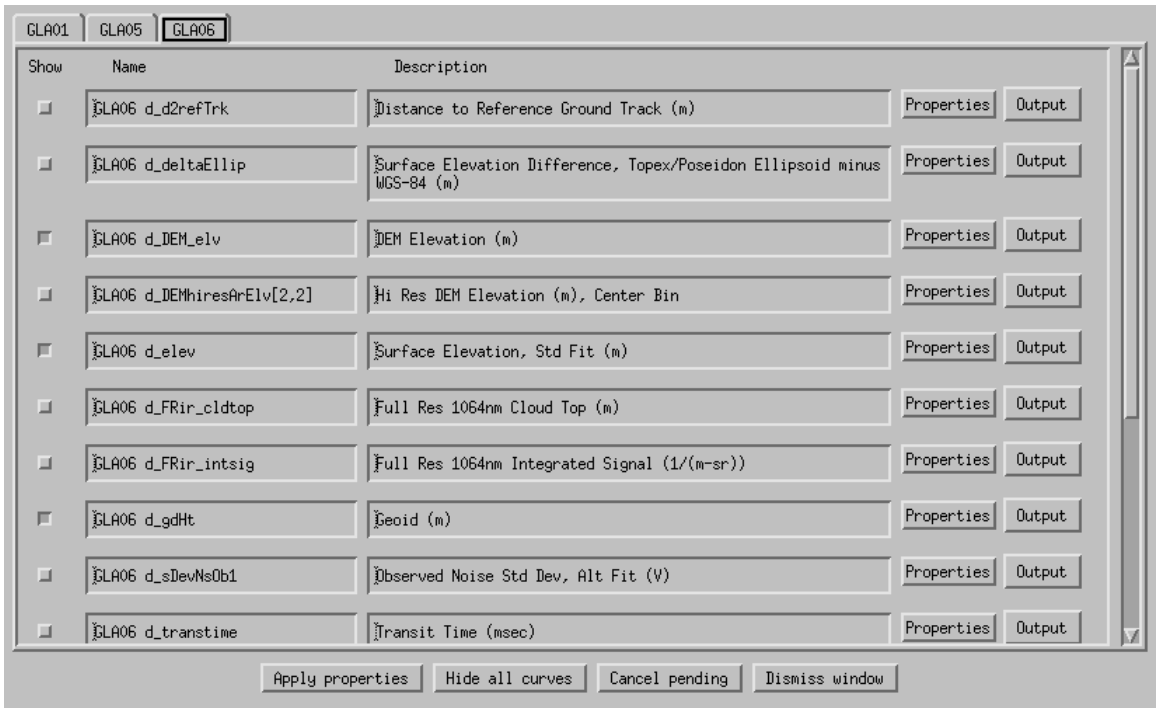

Figure 4-11: Curve window lists curves tabbed by product.

Each curve has the following two buttons:

Properties… -- Pops up a dialog window (Figure 4-12) that allows you to change the curve's label text, visibility (same as Show/Hide on the curve's menu), color, line style, point symbol, whether or not to connect the points, and line thickness of the particular curve. A label may be up to 3 lines long. The text in the "Default Label" box cannot be changed, and will be used if the "Curve Label" box is empty. To not use any label, put space characters (only) in the Curve label box. Line thickness is in pixels for screen plots, or units of 0.5 pts for PostScript (1 pt = 1/72"); ie., thickness=2 will produce a PostScript line 1/72" wide. Click OK to accept the changes, redraw the plot, and dismiss the window; or Cancel to dismiss the window without modifying the plot.

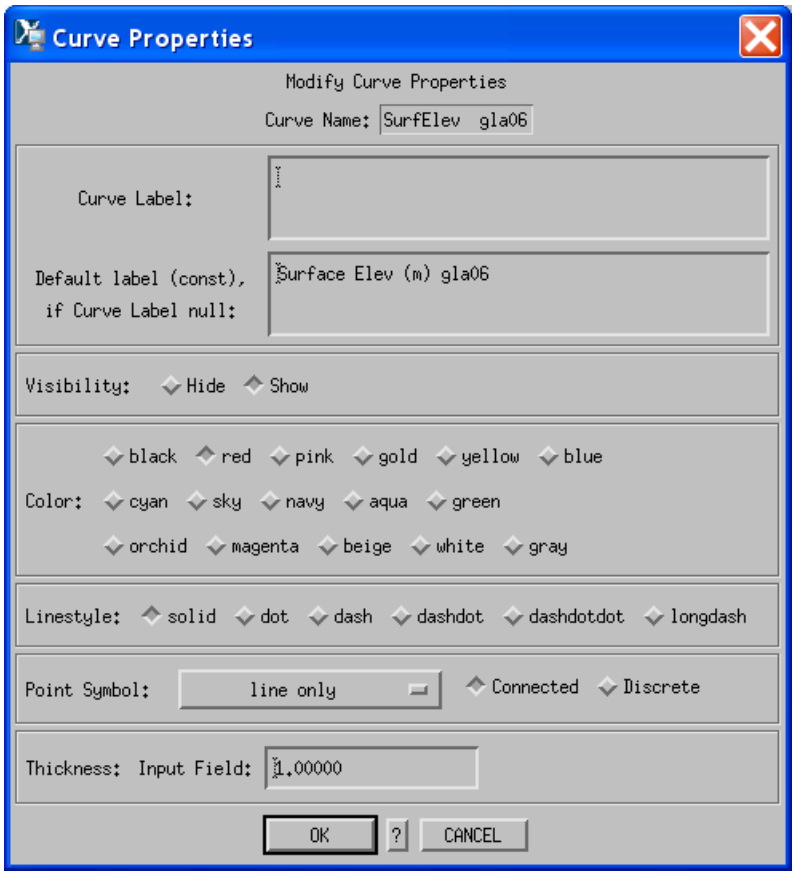

Figure 4-12: Curve Properties dialog.

Output button – This menu allows you to print the curve's data values to a text file or view them in a screen window. "**Spreadsheet style to file**" prints the data to a text file in X,Y columns, whereas "**Programmer style to file**" outputs all the X values followed by all the Y values, which is easier to read into languages such as Fortran and IDL. Both have headers in *keyword=value* format that give the array dimensions and other information. "**Show (x1, x2, …) in window**" and "**Show (y1, y2, …) in window**" let the user view the X or Y data values in screen windows (Figure 4-13). Dismiss the window by clicking "**File**", then "**Done with…**". Note that the values shown or written are those plotted; they will not necessarily be the same as what's in the product files, for instance if the Visualizer applied its own additional scaling.

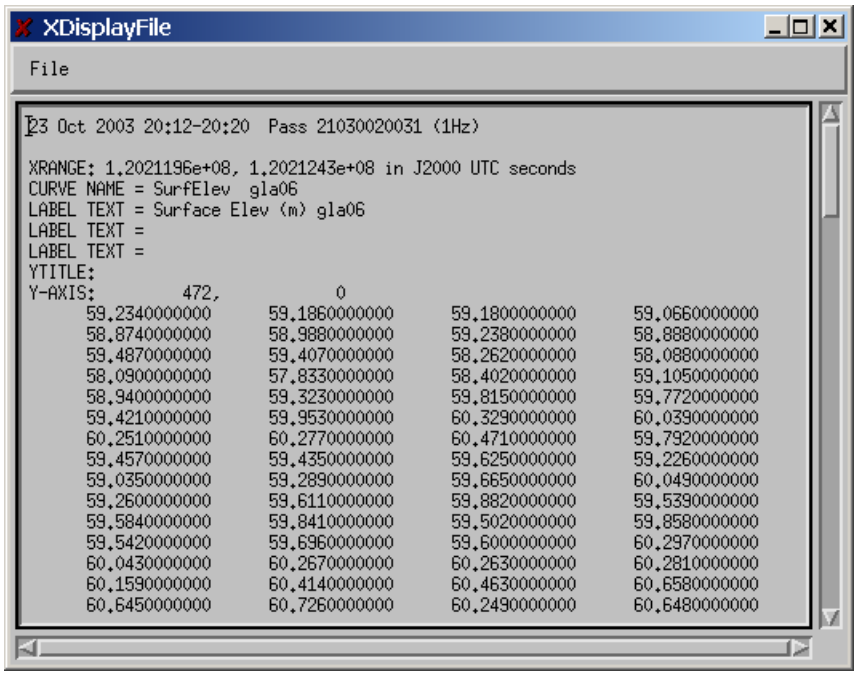

Figure 4-13: Output from "Curves…", "Print Data", "Show … in Window"

Some curves now have an option labeled "**Dump Field…**" under the "**Output**" button. This allows you to dump to an ASCII file the product-file field that was plotted as that curve, along with the unique index, shot number, time (J2000 UTC seconds), latitude, and longitude, for each shot or record. So far this is only available for GLA06, 12, 13, 14, and 15 curves on the Elevations, Range Corrections, Flags, Meteorology, and Range Increments series plotsets, but we plan to implement it for the rest in future releases. Shots are numbered 0-39, in the IDL convention. 1Hz fields are shown as shot 0. Values are reread from the product file and scaled to their natural, "algorithm" units, so may not be precisely the same as plotted: Some curves have an additional scaling applied within the Visualizer, which will not be in the dump; and dumps are always at the product field's full resolution, even from 1Hz plots. The range of the field dump will be the full range of the data available in the plot (the xrange plot property is not taken into account), rounded to a full record on either end; be sure to keep this in mind if comparing a field dump to the plot! When multiple curves are plotted from the same "algorithm" field, all parts of the field are dumped. For example, GLA14 Gaussian amplitudes (d_Gamp) are plotted separately for each peak, but the field dump includes all peaks; thus, you need not dump each peak separately. (This does not apply to those "product" fields, such as some flags, that are unpacked into multiple "algorithm" fields, only to the components of the same algorithm field.) The first line of the output file will always be "NUMHEAD =…;", giving the number of header lines; the data will immediately follow the last header line ("END;"). You will have the opportunity to add comments that will be included in the header of the dump output file.

Other buttons on the plot window:

Curve Props… button (Difference pane only) – This button pops up a dialog window to modify the properties of the curve shown in the Difference plot. It's identical to the Properties button for an individual curve in the main plot's Curves menu (Figure 4-12).

Plot Props…button – The "**Plot Props…**" button (Figure 4-14) brings up a dialog box that allows one to change scales, character sizes, line widths, decorations, and other plot properties on the screen or to create publication quality plots. The dialog box has three tabs, for general plot properties, X-axis properties, and Y-axis properties.

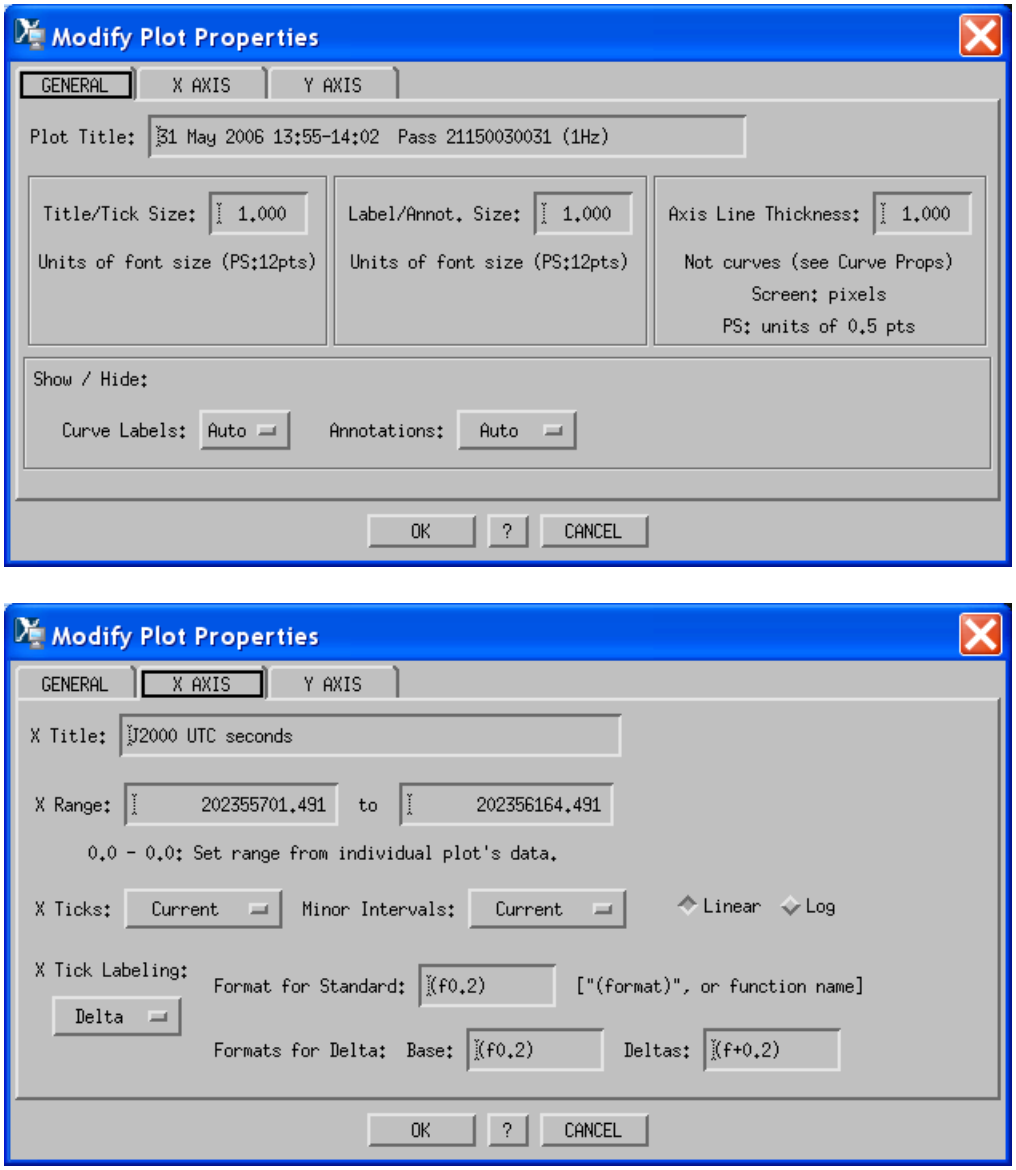

Figure 4-14: Plot Properties dialog. ***Top:*** **General plot properties tab.** ***Bottom:*** **X-axis properties tab. The Y axis tab is similar.**

"GENERAL" tab – This tab contains properties that affect the entire plot. "**Plot Title**" is the text for the main title printed across the top of the plot. "**Title/Tick Size**" specifies the character size to use for the main title, axis titles, and tick labels. IDL automatically increases the main title character size by 25%. "**Label/Annot. Size**" is the character size to use for the curve labels

(upper left corner of the plot) and plot annotations (upper right: Start/End, UIX, UTC, location, etc.). Character sizes are specified in multiples of the standard font size, or 12 points for PostScript plots. "**Axis Line Thickness**" is the how thickly to draw the axis lines and characters (but *not* the curves, which are controlled separately by the curve properties). Thickness units are pixels for screen plots, or 0.5 points for PostScript (1 pt = 1/72"). The "**Show/Hide Curve Labels**" drop list allows you to choose whether to show the curve labels on the plot. "Auto" (the default) lets the program select based on the size of the plot. "**Show/Hide Annotations**" chooses whether to hide the annotations, show them in less detail ("Level 1", in general intended for smaller plots like thumbnails (section Waveform Thumbnails)), show in more detail ("Level 2", intended for larger plots like time series or zoomed thumbnails), or let the program decide ("Auto", the default). Not every plot has both Level 1 and Level 2 annotations.

"X AXIS" tab – This tab contains properties of the X axis. "**X Title**" is the title shown under the X axis. "**X Range**" is the data range for the X axis; if given as 0.0 to 0.0, the range will be set automatically from the data. "**X Ticks**" is the number of major ticks on the axis; "current" keeps the current number, "IDL default" lets IDL decide. "**Minor Intervals**" is the number of minor tick *intervals* between each pair of major ticks. "**Linear**" and "**Log**" specify just that. "**X Tick Labeling**" = Standard means to use standard labeling for major ticks, where the label is the actual value. Delta means to use "Delta Tick" labeling, where only the first tick has its actual value and subsequent tick values are deltas (+/-) from the first. "**Format for Standard**" is the IDL format code (*Note:* parentheses required!) to use to format tick labels when using Standard labeling. This can also be the name of a user-defined callback function that given a tick value returns a formatted string; see the IDL documentation for details. "**Formats for Delta: Base**" gives the format code for the first tick label when using Delta Ticks labeling; "**…Deltas**" is the format for the subsequent delta labels.

"Y AXIS" tab – This is just like the X Axis tab, but pertains to the Y axis.

"OK" button – Accepts any changed properties, redraws the plot, and dismisses the dialog.

"?" button – Pops up a window with help text.

"Cancel" button – Dismisses the window without making any changes.

Other available altimetry plotsets include:

- Waveform Characteristics
- Range Increments
- Range Corrections (called Tide, Troposphere, and GPS Corrections prior to release 200609.0)
- Angles (spacecraft and instrument orientation)

- Meteorology/Cloud/Aerosol Parameters (temperatures, pressures, humidity from GLA06-15, data release 24 and above only; also specific humidity, temperature at 2m altitude, and total cloud cover from GLA08-09 at data release 26 and above.)

4.3.1.1 Waveform Thumbnails

If GLA01 has been selected, right clicking on any portion of the time-series profile in an altimetry plot set and then clicking on "Display Waveforms" will display corresponding waveform thumbnails in a ThumbnailViewer window, as shown in Figure 4-15, beginning at the location of the red vertical cursor, with waveform parameterization results if GLA05 was also selected. Thumbnails are displayed 20 at a time (0.5 second), top to bottom then left to right; ie., the first thumbnail (timewise) is in the upper left corner, the fifth in the lower left, and the twentieth in the lower right. (This ordering was requested by the GLAS Science Team in order to more easily see trends in sequential thumbnails.)

Paging backwards or forwards through the thumbnails will also cause the red vertical line to be plotted on any open plot sets, positioned to the corresponding time on all profiles. Similarly, repositioning the red line on any of the series plots with the right mouse button will move the waveforms window to show waveforms starting at the selected time. Clicking on any one of the thumbnails will bring up a large version of it in a ThumbnailZoom window as shown in Figure 4-16. Any LIDAR backscatter profile thumbnail window (section Lidar Backscatter Profiles) will also be repositioned.

Note that if GLA05 data is available for this record, the latitude, longitude, and elevation shown on each waveform are taken from GLA05 even if higher products were also selected, and thus do not include all corrections. On the zoomed thumbnails, this is indicated by "(uncorr)". Otherwise, the location shown will be the *predicted* location of

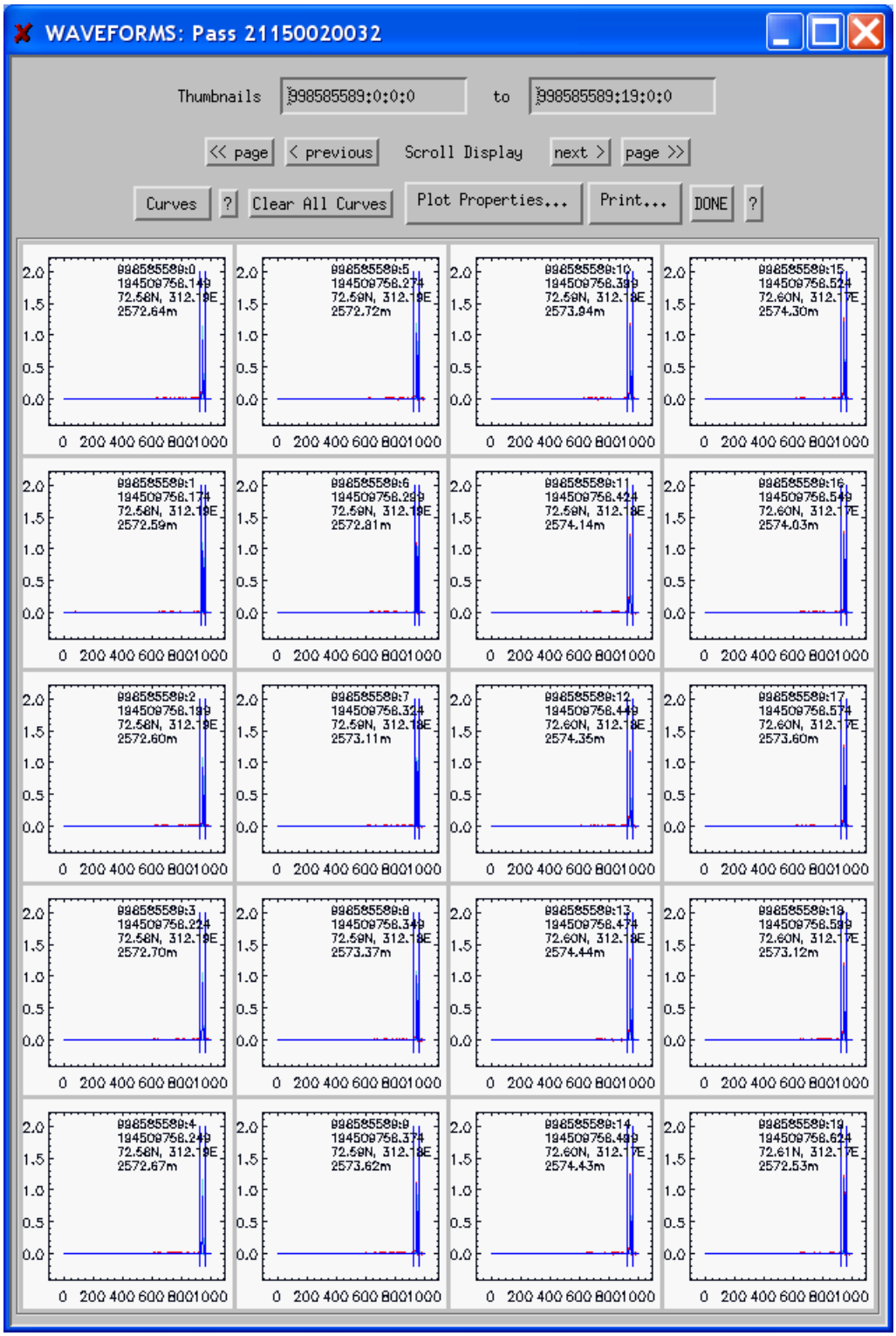

Figure 4-15: Waveform thumbnails with parameterization results from GLA05. Annotations on each thumbnail are: unique index:shot number; shot time in J2000 seconds; latitude and longitude; and with GLA05, elevation. The X scale is relative time in nanoseconds, the Y scale units vary with the curve shown but are listed on the Curve buttons. Note that latitude and longitude are uncorrected GLA05 locations, or if GLA05 is not available, predicted GLA01 ones.

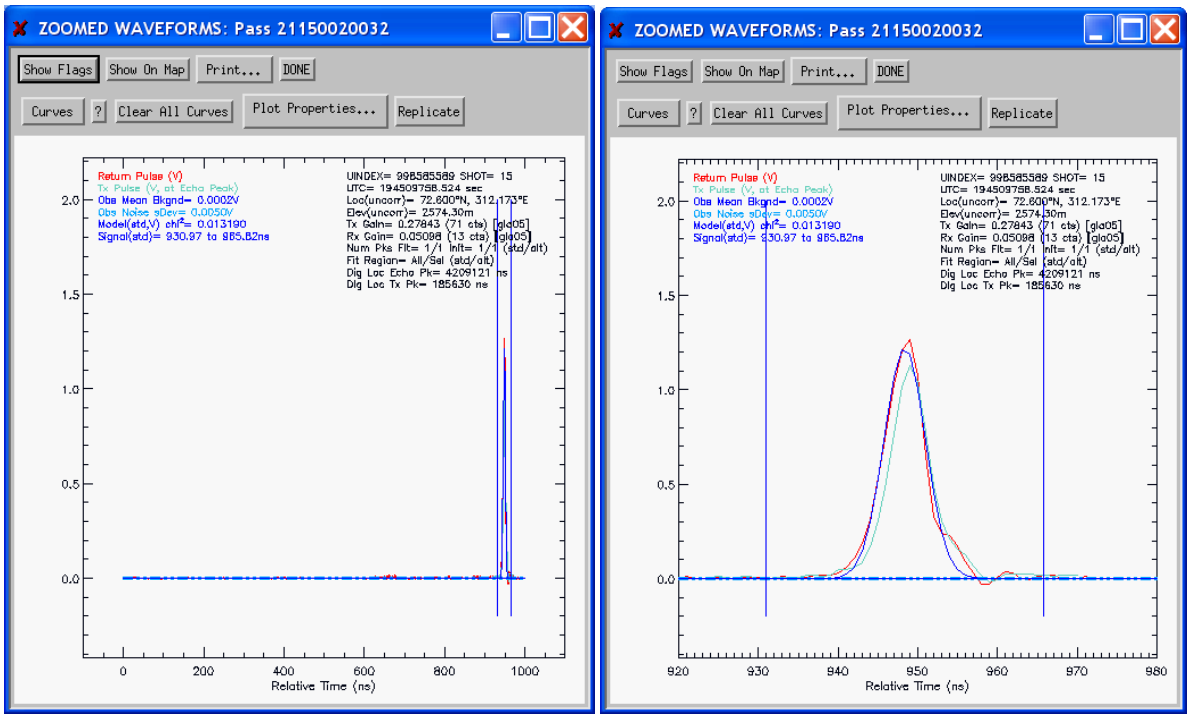

Figure 4-16: Zoomed waveform thumbnails. In the thumbnail on the right, the user has used the "Plot Properties…" button to change the X-axis range, to better show the waveform.

the *first* shot in that 1-second record. This is due to the design of the GLA01 product, and is indicated by "(pred)".

Scroll Display buttons (ThumbnailViewer only) – These buttons scroll through the available waveforms. **"<< page"** displays the previous 20 thumbnails. **"< previous"** brings the preceding thumbnail onto the display in the upper left and slides the rest down. **"next >"** adds the next thumbnail on the lower right and slides the others up. **"page >>"** displays the next 20.

Caution: Do not be too quick on the mouse when paging back and forth on the thumbnails or the program may get confused and do weird things. Pushing the "DONE" button in the thumbnail window will usually stop this, after a while.

Curves button – Works in the same manner as for the time-series plots, but applies to all thumbnails in the window.

Clear All Curves button – Clears the plots of all curves.

Plot Properties…button – Works in the same manner as for the time-series plots, but properties apply to all thumbnails in the window. This button also provides options to save the properties to and restore from a file.

Print… button – Allows you to make a PostScript plot that shows all the thumbnails in the window. (**Caution**: IDL will automatically reduce the titles and tick labels, but not curve labels or annotations, by 50%. Make appropriate adjustments to the character size using the "Plot Properties…" button.) Individual thumbnails have a 1:1 aspect ratio, so use 4:5 for printing the entire window. Remember to use the "Close PS File" button when you've completed the plot.

Note: The ThumbnailViewer and ThumbnailZoom "Print…" button option "Print data rec of 1st tn" has been removed. It was implemented in a way that precluded use of the IDL Virtual Machine, did not work for most products, and when it did produced voluminous output, most of which was of little use. Instead, we recommend you zoom the thumbnail you want and use the "Print data…" options on the Curve menu for the curve you're interested in. (We plan to add the Field Dump feature to the ThumbnailViewer and ThumbnailZoom in a future release.)

DONE button – Closes the window.

Show Flags button (ThumbnailZoom only) – This button will only appear if GLA05 data is available. Pops up a window that shows the states of the waveform quality flags for this waveform.

Show On Map button (ThumbnailZoom only) – Clicking this button will position the location marker (green diamond) on the Groundtrack Map window (Figure 4-6) to the location of this waveform (or if GLA01 only, the predicted location of the first waveform in the record).

Replicate button (ThumbnailZoom only) – Makes a clone of this window. Each window has its own set of properties, making this useful for studying the data at different scales, or showing different curves in separate windows.

4.3.2 Lidar Plotsets

LIDAR plotting capabilities are similar to the altimetry ones described in Section Altimetry Plotsets above. Currently available lidar plotsets are GLA02 Normalized Lidar and GLA07 Attenuated Backscatter profile images at 532nm and 1064nm, GLA02 and 07 Energies and Backgrounds, GLA10 and 11 Cloud and Aerosol Layers, GLA11 Optical Depths, and GLA11 Particle Size Estimates. Clicking on one of the "normalized lidar" or "attenuated backscatter" plot sets brings up a time-series backscatter profile image for the pass as displayed in Figure 4-17. At the request of the ICESat Lidar Science Team, the backscatter image data is averaged over 1 second. The zoom bars can be dragged from each side of the image to select a zoom region and pushing the "zoom" button will create another plot window of the zoomed region as shown in Figure 4-18. If GLA08 or GLA09 was selected, a variety of cloud, aerosol, and topographic elevations may be superimposed on the backscatter images (these may still be viewed even if GLA02 and GLA07 were not selected). There will be no difference windows with the backscatter images *unless* GLA08 or GLA09 was selected. Note that a Postscript output file of a backscatter image is likely to be very large; some people prefer to simply use screen-capture tools, but these produce lower-resolution prints.

Display Lidar Profiles button – Right clicking on any portion of the image and then clicking on "**Display Lidar Profiles**" will display thumbnails of the corresponding individual backscatter profiles; see Section Lidar Backscatter Profiles.

Other buttons – See Section Altimetry Plotsets.

The current color scale ranges for the lidar windows are:

532nm Normalized (GLA02): -2.0e7 to 1.2e8
532nm Attenuated (GLA07): 0.0 to 1.0e-5
1064nm Normalized (GLA02): 1.0e-4 to 4.0e-4
1064nm Attenuated (GLA07): 0.0 to 1.0e-4

Additional lidar plotsets available include:

- GLA02, GLA07 Lidar Energies and Backgrounds
- GLA10, GLA11 Cloud and Aerosol Layers
- GLA11 Optical Depths
- GLA11 Particle Size Estimates

These are all time-series plotsets similar to the altimetry ones, but include a "**Display Lidar Profiles**" button rather than a waveforms one. Meteorology parameters from GLA07-11 are on the altimetry Meteorology plotset.

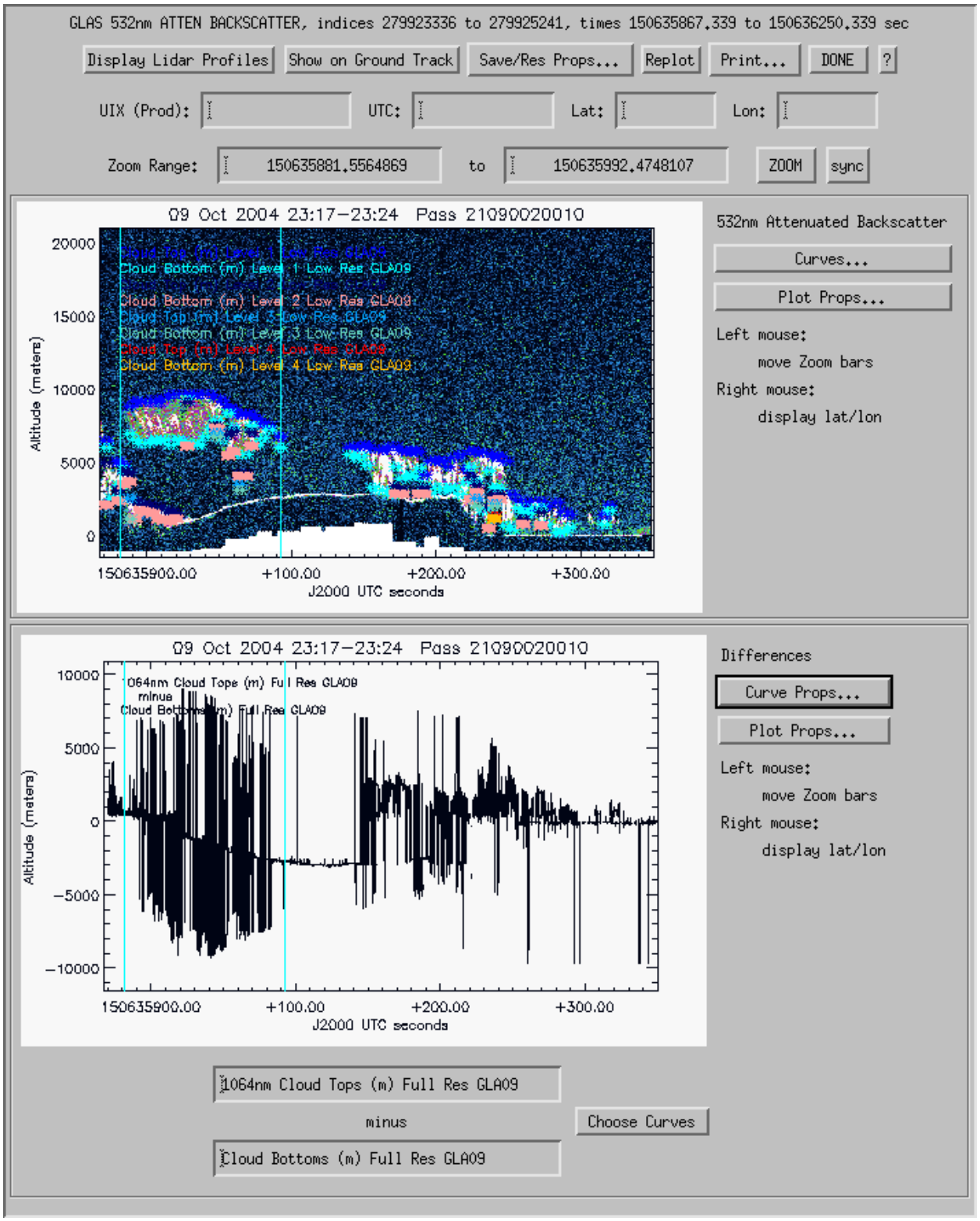

Figure 4-17: LIDAR Image plot set (GLA07 532nm Attenuated Backscatter). The difference plot is showing full-res cloud thickness (cloud top height – cloud bottom height). The difference plot will only appear if GLA08 or GLA09 was selected.

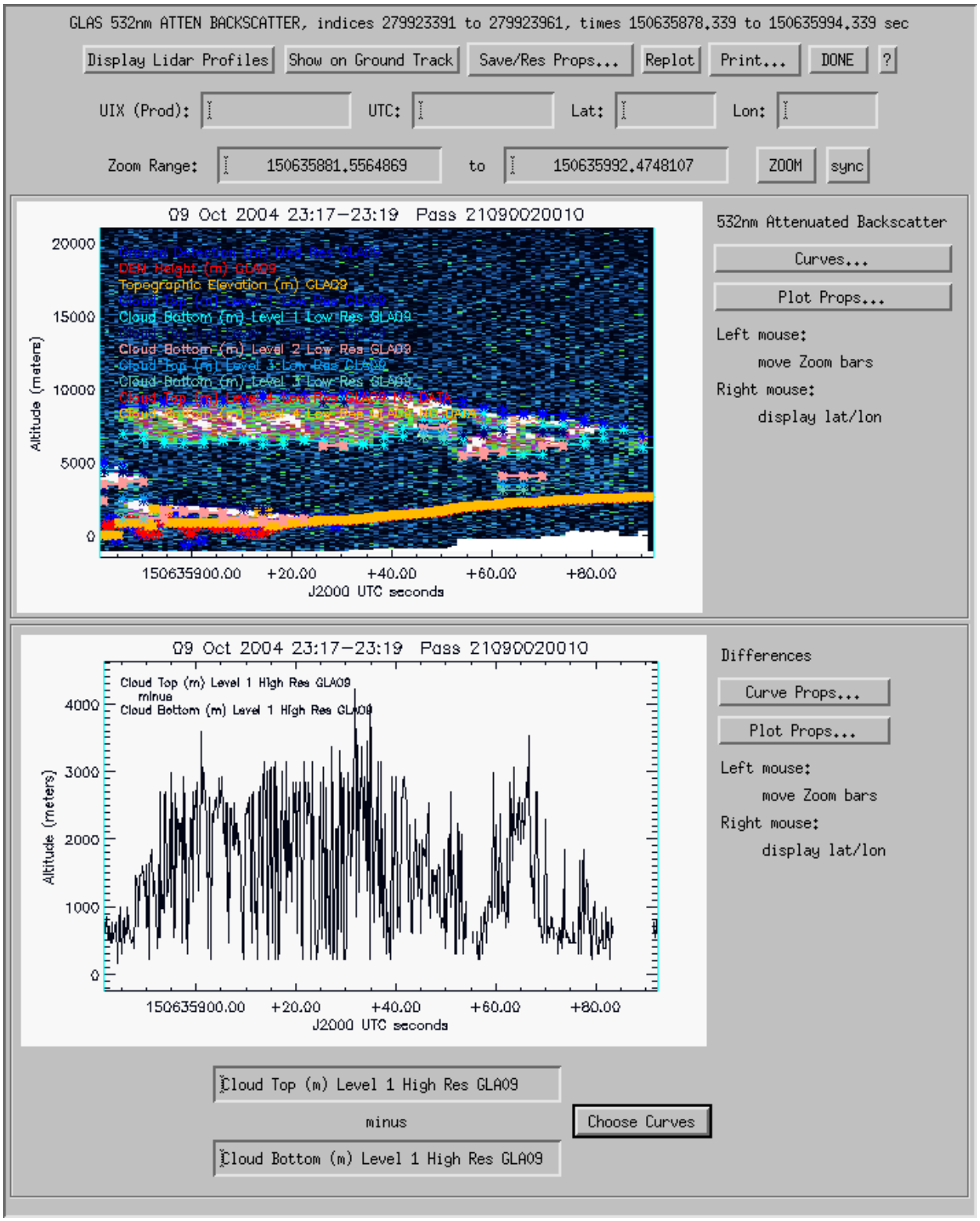

Figure 4-18: Zoomed LIDAR image profile, with cloud layers, elevation, DEM, and ground detection overlays. The difference plot is showing the thickness of the first cloud layer.

4.3.2.1 Lidar Backscatter Profiles

Right clicking on any portion of a lidar plotset and then clicking on "**Display Lidar Profiles**" will display the corresponding individual backscatter profiles as shown in Figure 4-19. (Note: Currently, for GLA02 only the 532nm profiles are initially shown, even when the lidar profiles were launched from a 1064nm image. We plan to rectify this in a future release. For GLA07, both sets of profiles are shown.) These windows work the same as the waveform thumbnails described in Section Waveform Thumbnails. Left clicking on an individual profile will bring up a zoomed window of that profile as displayed in Figure 4-20. If one has both LIDAR and altimetry data and has displayed both the waveform and backscatter thumbnails, paging through one set of thumbnails, causes the other set to also page to the new location. Repositioning the red cursor on any time-series plot will also reposition the LIDAR thumbnails, and scrolling any of the thumbnail windows will also move the red cursors in all the time-series windows and reposition any other thumbnail windows.

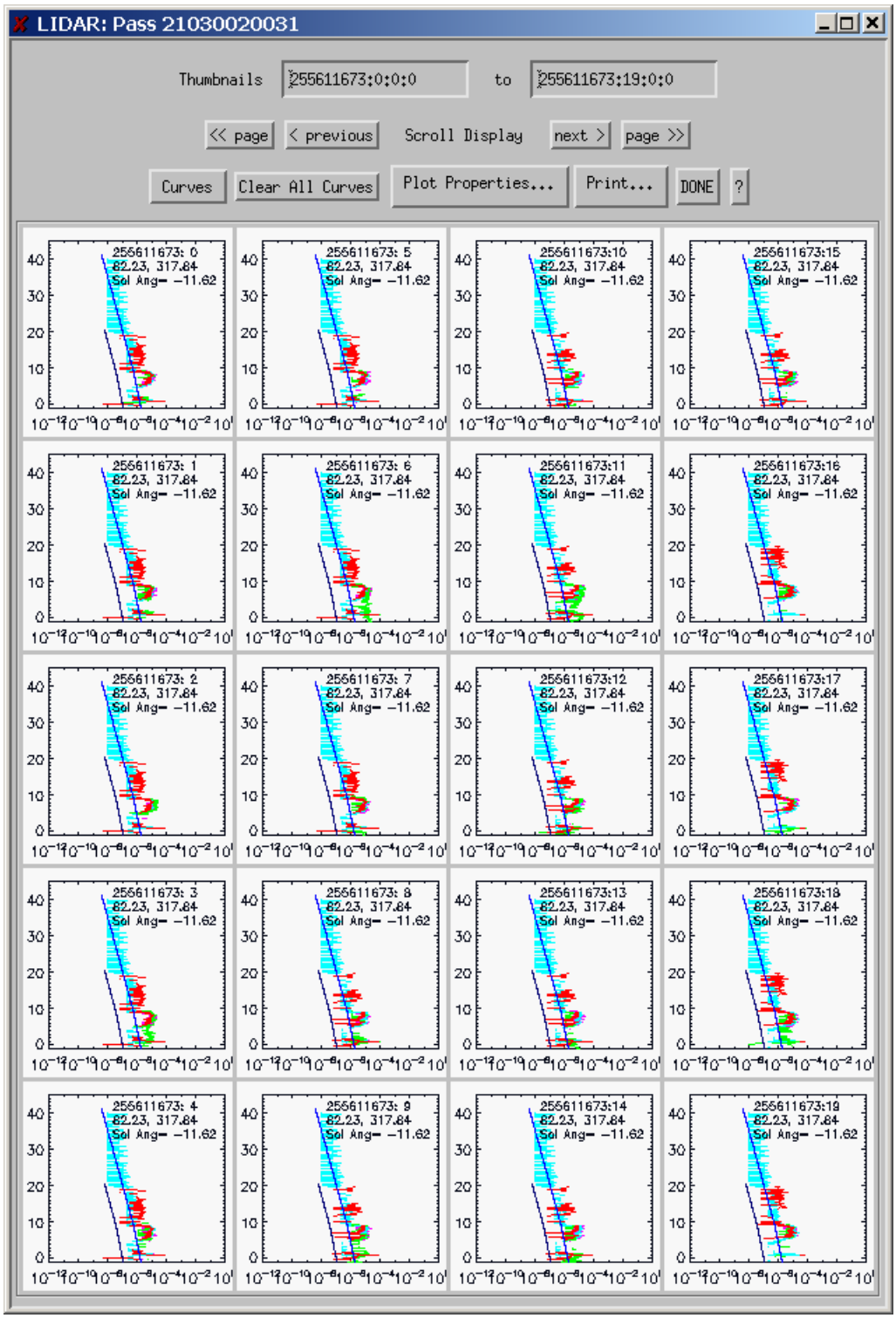

Figure 4-19: Individual backscatter profiles. Annotations: unique record index and shot number; latitude and longitude; sun angle. The X scale is energy; the Y scale is altitude in km.

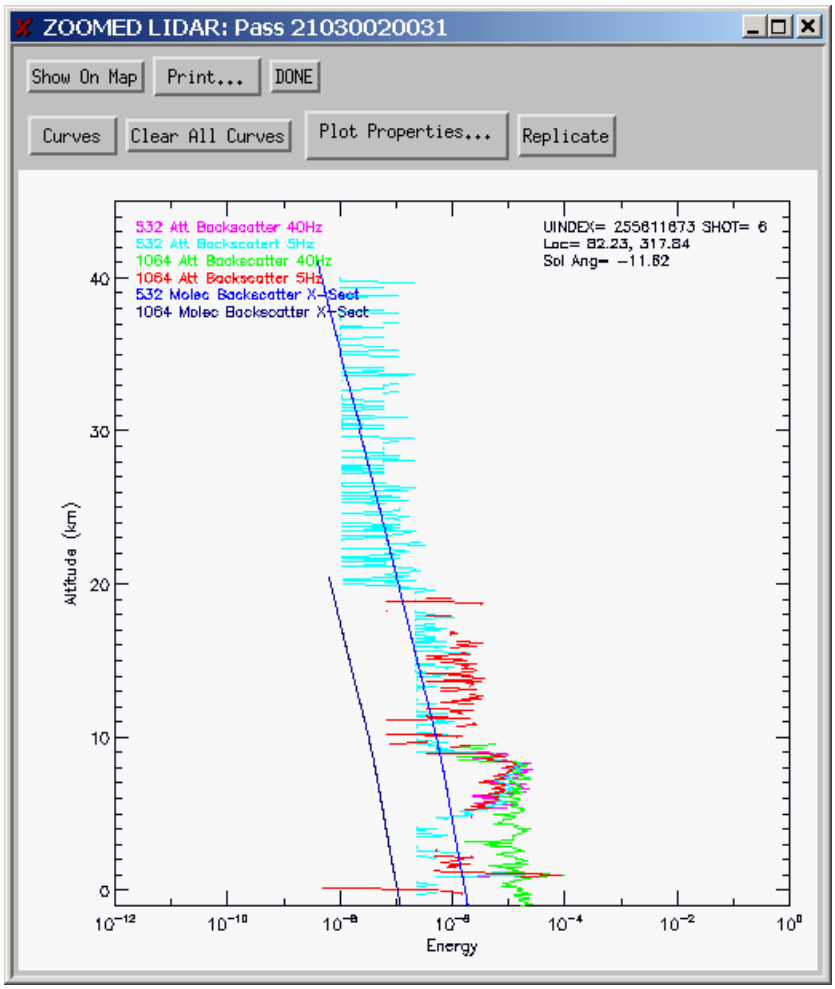

Figure 4-20: Zoomed backscatter profile

4.3.3 Miscellaneous Plotsets

Other available plotsets include Laser Profiling Array (see Figure 4-21), Flags (see Figure 4-22), and Waveform Intensity Image (see Figure 4-23).

Selecting the Laser Profiling Array plotset brings up a window of GLA04 LPA thumbnails, as shown in Figure 4-21. The x and y scales are simply pixel numbers. Each thumbnail shows the unique index and shot number in the upper right corner, with the time (in J2000 seconds) below it. (Note that the origin is now in the upper left, with row numbers increasing downwards. The old orientation may be easily restored by clicking on Plot Properties and reversing the Y-Axis Range.) This window works the same as the Waveform and Lidar thumbnail windows. Clicking one of the thumbnails will bring up a zoomed version of that plot. Repositioning a red cursor on one of the time-series plots, or scrolling or paging a Waveform or Lidar thumbnail window, will replace the thumbnails shown here with those at the new location; likewise, scrolling or paging this window will reposition other thumbnail windows and the red cursors on the time-series plots.

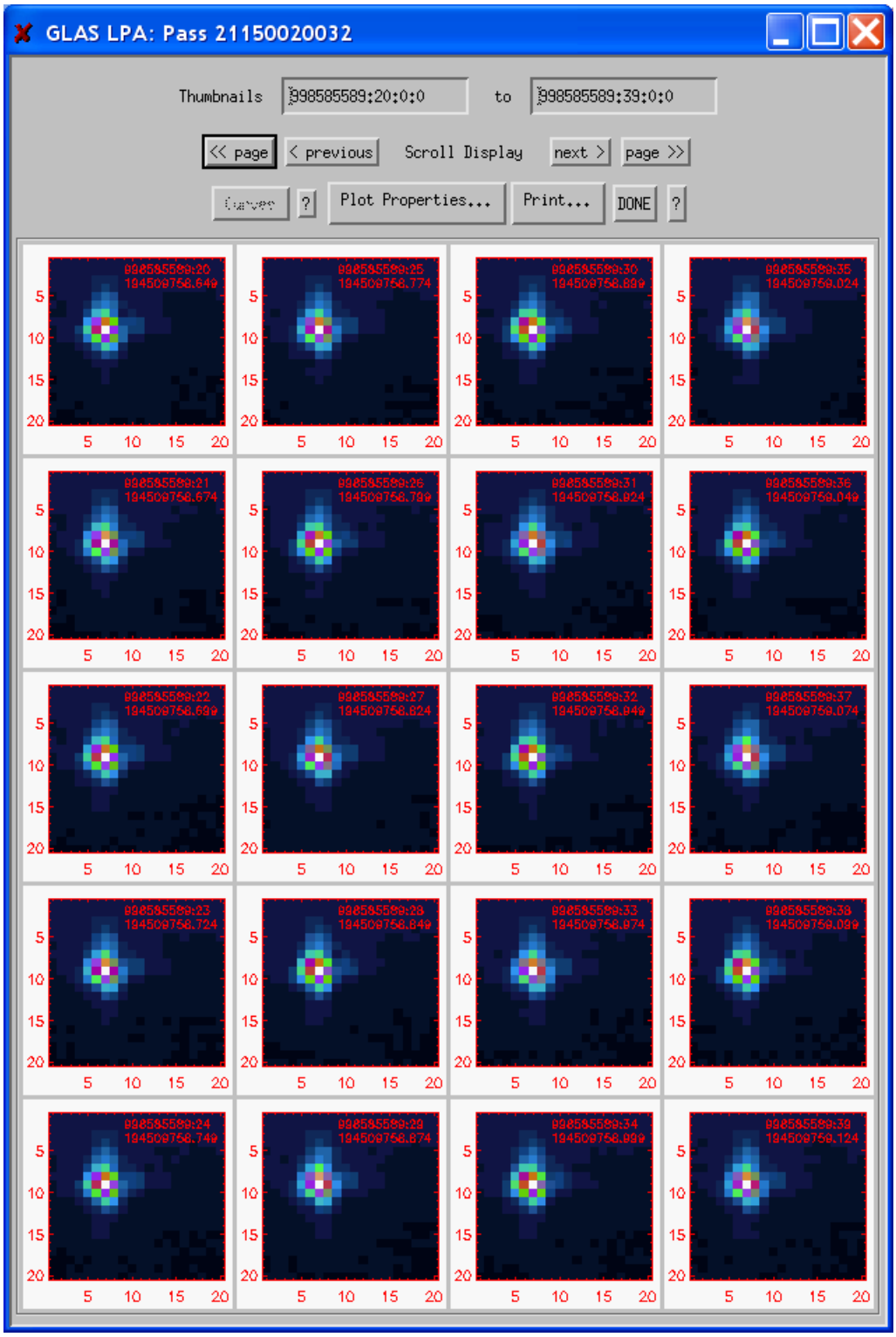

Figure 4-21: Laser Profiling Array

The Flags plotset (see Figure 4-22) is a time series plot that allows monitoring the values of the flag fields in all selected products. All flags from all products are available, except for the vertically-binned saturation flag profiles from GLA02 and GLA07. No difference window is shown.

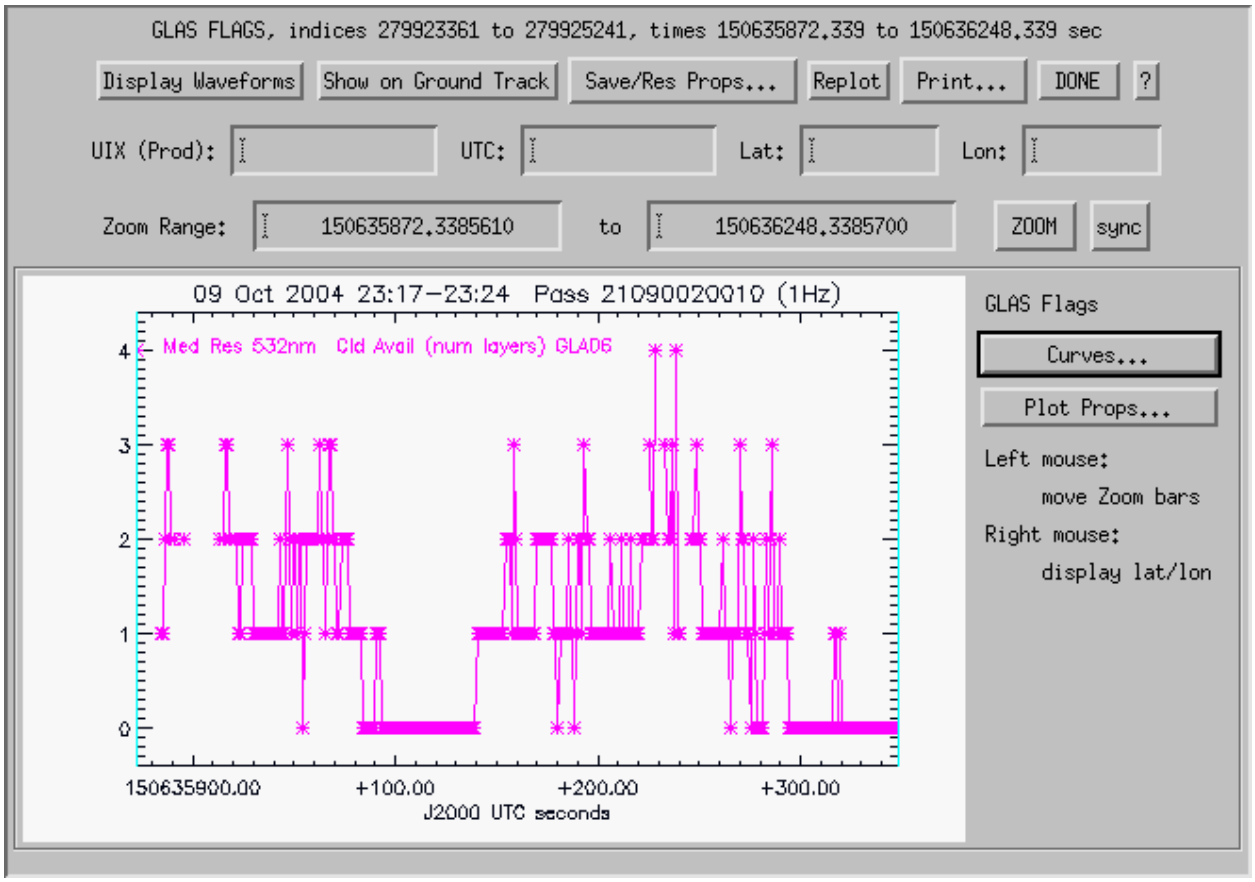

Figure 4-22: Flags plotset, shows time-series of specific parameters

The Waveform Intensity Series plotset (see Figure 4-23) is a time-series image of the intensity of the returned waveforms. The y-axis is gates (note: Not nanoseconds as in the waveform plots!) before end of waveform digitization. The large black areas are due to the use of 544 digitzer gates over land and ice sheets and 200 gates over ocean and sea ice. There is no difference window.

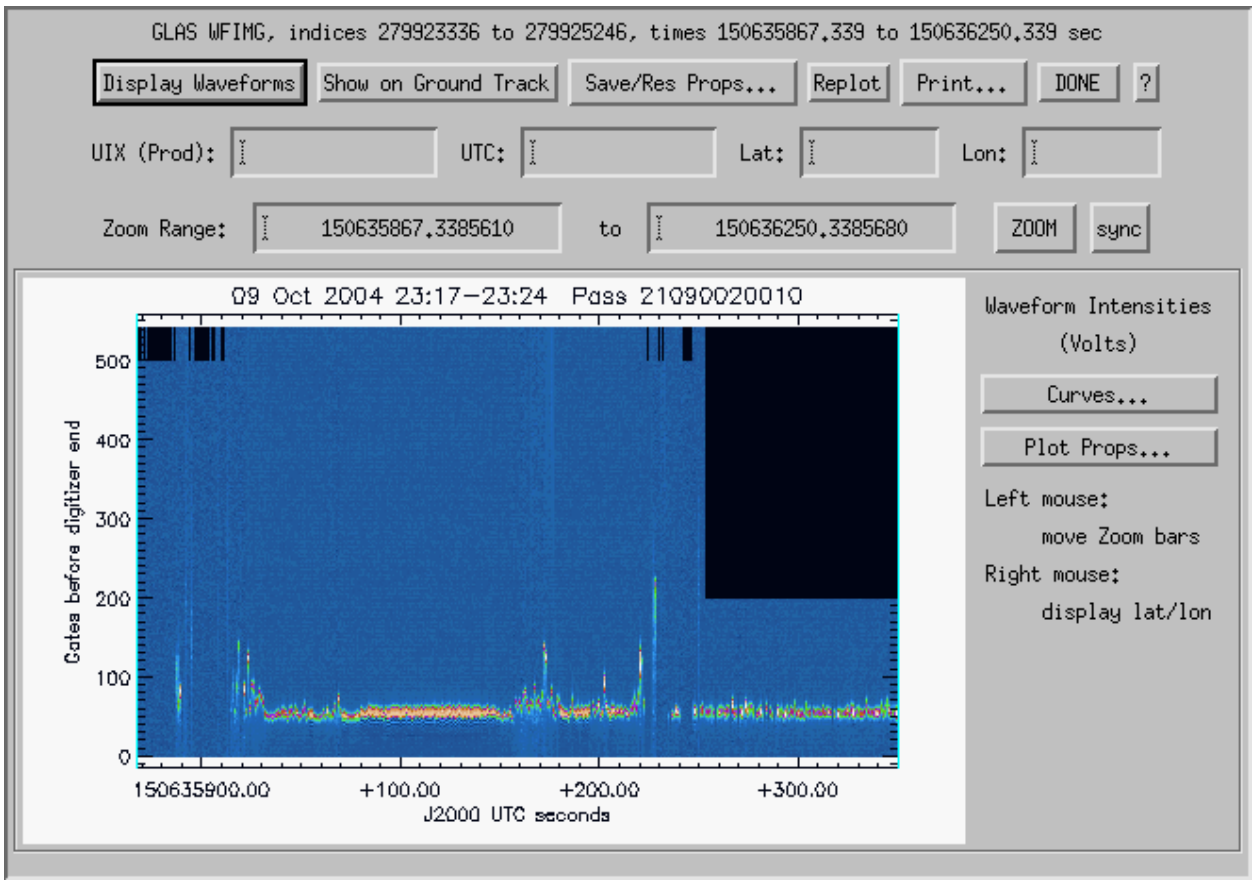

Figure 4-23: Waveform Intensity Image.

4.3.4 Some Notes about this Version

- You can keep going back to the initial elevation and LIDAR thumbnails (pass selection) and select more and more passes without closing any windows and probably eventually cause the program to crash.
- Try to close any windows that are no longer necessary as you continue on your way. It is best to use the buttons within the window labeled "Done" or "Close"; while closing via the X button won't *usually* crash the program any more, it may still in some cases.
- Paging through the thumbnails too quickly (double clicking, etc) can get you in a loop where the event handlers just keep generating new events. Try to restrain yourself. Sometimes clicking the "Done" button several times will get you out of the loop (and will probably close the thumbnail window).
- There is now a limit on how far the groundtrack window can be zoomed. This avoids an IDL bug that caused crashes when zooming too far.
- Occasionally the groundtrack drawing window will become unresponsive so that you can't drag out a zoom box. If this happens, clicking the "Replot Map" or "Clear Map" button will usually fix the problem.

- Positioning the location cursor on a time series plot (by right clicking) will only affect the cursors on the other time series if a waveform or lidar profile thumbnail window is displayed.
- The Meaning of "NaN": Sometimes the string "NaN" will appear in place of a number. This stands for Not-a-Number, which is a feature of IEEE-standard floating-point computer arithmetic. (For example, 0./0. is a NaN.) It's used in the Visualizer to indicate invalid values. Any particular language or compiler may or may not be able to parse "NaN" as a real number (IDL can); you may need to experiment and possibly edit out any lines containing "NaN". The use of NaNs is also the cause of the harmless "Program caused arithmetic error: Floating illegal operand" messages you are likely to see.
- Could the Visualizer plot series by latitude or longitude, instead of by time? Sorry. This is a common request, and we can certainly appreciate why you would want to. But while this would work over a short range, remember that the Visualizer must work for GLAS data in the general case: Consider a plot by latitude as the spacecraft passes the pole, or a longitude plot at low latitudes where the track is steep. Keep in mind too that one plot may go all the way around the world! Furthermore, there won't necessarily be data at the position of any particular tick. We concluded that plotting by time – which corresponds to distance along track – was really the only feasible way.

Appendix A: Practice Exercises

The exercises below were designed to show the user the capabilities of the Visualizer and illustrate how the Visualizer can be used to investigate science algorithm performance. They will also help the user understand what parameters are written on each GLAS standard product and learn how the products interact with each other.

To push a button on a GUI, use the mouse to move the cursor over that button and push the left mouse button. All instructions that say "click" or "push" assume you are clicking the left mouse button unless the right mouse button is stated explicitly.

A.1) Waveform and Elevation Exercise

The purpose of this exercise is to look at the waveform and the waveform parameterization to see what the raw return may look like and the results of the waveform-processing algorithm. This exercise looks at GLA01 and GLA05 products over Greenland that are available in the test set that comes with the Visualizer.

Step 1.0 **Select data to view.**

1.1 Invoke the Visualizer.
1.2 Press the "Subset Data" button.
1.3 Press the "Pick" button at top, pick the data directory. The test data are in the "data" directory of this delivery. If the path is correct, just press "Ok". If not, then select the correct path and then press "Ok".
1.4 Press the "Data Product Menu" button. Select products GLA01 and GLA05 and then press "Done".
1.5 Press the "Greenland" button to select the region.
1.6 Press the "Push to List Tracks w/i Region: button under "91 Day Repeat". Click the "Select All" button to select both tracks 2 and 10.
1.7 Press the "Continue" button to subset the data.
1.8 When the "Elevation Profiles" window comes up, click on one of the plots.

Step 2.0 **Select what set of parameters to view.** In the "GLAS Series Plot Sets: Pass …" window the parameters have been grouped by subject matter into plot sets. The plot sets available to look at are dependent on what products you selected. Since GLA01 and GLA05 products were chosen, you should see the following plot sets:

- Elevations
- Waveform Characteristics
- Range Increments
- Range Corrections
- Angles
- Flags
- Waveform Intensity Series

Click the boxes next to "Elevations" and "Waveform Characteristics". Then push the "Display Selected Plotsets" button. It will take a few seconds (20 or so) to load the parameters. Two windows will appear: one with "GLAS WF_CHAR" and one with "GLAS ELEVATION".

Step 3.0 **GLAS WF_CHAR window:** Initially the transmitted energy and received energy profiles are plotted.

From the "Curves…" menu you can also plot:

- Received and transmitted energy from GLA01.
- Received and transmitted gain from GLA01 and/or GLA05.

- Waveform compression information.
- The difference in km between the received echo peak and the transmitted waveform peak.
- How close the echo peak is to the last telemetered gate.
- The width of the signal based on first and last threshold crossings.
- The difference between the first threshold crossing and the last gate.
- The time in digitizer counts (ns from turn on of the digitizer) of the transmit peak.
- The echo peak location in digitizer counts.
- The maximum amplitude of the smoothed waveform.

The bottom plot in the plot set shows the difference between any two parameters available in this plot set.

3.1 **See what parameters are available to plot in this window.** Click on the "Choose Curves" button. A curves window appears showing you which parameters are available to plot. Parameters for GLA01 and GLA05 appear in separate tabbed lists. The GLA01 list is shown by default.

3.2 **Change properties of specific curve.** Go to the "Received Energy, Max Peak (fJ)". curve. The Show button will be indented indicating that the curve is displayed. Select the "Properties" button next to the curve. A new window will pop up that will allow you to change the curve properties of just this parameter. Click the radio button next to "red". Then push the "OK" button in bottom of window. Now press the "Apply properties" button on the curves window. Note that the Received Energy is now shown in red.

3.3 **Output the values in a curve to an ASCII file.** Repeat the step above, but click on "Output" instead of "Properties". You may see the x and y data values output to a window by selecting either of the "Show (…) in window" buttons. To output the values to a file, select either "Programmer style to file" or "Spreadsheet style to file". "Programmer style" writes the entire X array, followed by the entire Y array; this is easier for programs like IDL to read. "Spreadsheet style" writes the X and Y arrays as columns. A new window pops up that lets you choose the file in which to write the data. Make sure you have write permissions in the directory in which you are creating the file, or change the directory appropriately. If you accept the default, it will go in the directory you were in when you invoked the Visualizer as the default file for that parameter. If the file already exists, this data will be concatenated onto the existing portion of the file. Click OK to write the data to the file.

3.4 Remove the energy curves by clicking "**Hide all curves**" then "Apply properties" in the curves window.

3.5 **Select a new parameter.** In the GLA01 curves list, select the "Threshold Peak Width (ns)" curve then press "Apply properties" to display. This is the width between the two threshold crossings calculated by our post-processing algorithm. Change the color by selecting "Properties" next to the parameter, selecting a new color, then

pressing "Apply properties" again. Exit the curves window by pressing "**Dismiss window**".

3.6 **Zoom** – use the turquoise zoom bars to select a portion of the x direction. If you cannot find the zoom bars, left-click anywhere within the graph and the closest zoom bar should appear, usually they are hiding on the extremes of the x-axis. Click and drag each zoom bar to where you want it. The zoom range is shown in seconds in the text buttons above the curve. Click the "Zoom" button (upper right) to zoom.

3.7 **Changing plot properties to customize plots.** Click the "Plot Props…" button directly under the "Curves…" button. A new window appears that allows you to change plot and axes titles, x-range, y-range, the format of the tick mark labels, and the type of plot (log or linear). Change the y-range to go from 0 to 1000. Push the "OK" button in bottom of window. You now should just see the portion of the curve that lies between 0 and 1000 ns.

3.8 **Show region on ground track.** Push the "Show on Ground Track" button for this zoomed window. Bring the "Groundtracks window" into the foreground by clicking on it and see that this portion is highlighted on the groundtrack. The actual ground track from the full rate data is being plotted now. Select "Greenland" and press "Replot Map" to see a close-up of the region. If you right-click on the zoomed plot to see the red line then press "Show on Ground Track", the teal cube changes position.

3.9 **Get rid of windows.** Bring the zoomed "WF Char" window to the foreground by clicking on it and push the "Done" button in the top right hand corned. Bring the original "WF Char" window to the foreground and push the "Done" button on it.

Step 4.0 **"GLAS ELEVATION" plotset.** Bring this window to the foreground by clicking in it. If you inadvertently closed it, just go back to the "GLAS Series Plot Sets" window, select "Elevations" and "Display Selected Plotsets" again.

The curves available in this plot set for GLA01 and GLA05 are:

- Surface Elevation – from the preliminary range on GLA05
- Noise – GLA05
- Transit Time – GLA05
- Background – GLA01
- On-board DEM – GLA01
- Surface Types – this is a code saying whether on-board DEM had this surface coded as land, and/or ice sheet, and/or sea ice, and/or ocean – GLA01

4.1 **Look at the difference** between the on-board DEM max and min. Click the "Choose Curves" button by the difference plot at the bottom of this window. Choose the on-board DEM max as the first curve and the on-board DEM min as the second curve. Press "Apply selection" when done. The difference plot now shows the difference between these two values.

Step 5.0 **Look at Waveforms and Waveform parameterization.** In the "GLAS ELEVATION" window, right-click anywhere on either graph. Then click the "Display Waveforms" button at the top of the screen. A "WAVEFORMS" window pops up showing 20 waveforms. The caption on each waveform lists the following its unique index, UTC and shot number; latitude and longitude; altitude. The raw waveform is in red and the fit is in blue. If you don't see two blue lines for the fit on the plot, scroll through the waveforms using the "next" or "page" buttons until you do. If we had not selected GLA05 you would only see the raw waveform. These are referred to as waveform thumbnails. The "Curves…" button on this multi-waveform plot gives you the same selection as on an individual waveform plot. On each plot set that is open a vertical red line appears showing the location on the plot set of where the waveforms are. We will now zoom an individual waveform and play with the parameters there since it is easier to see.

5.1 **Zoom waveform:** Left click on a waveform thumbnail and a "Zoomed Waveform" window appears. The curves button allows you to look at all the parameters on the product that we could plot on the waveform.

5.1.1 **Check the standard fit:** Using the "Curves…" button, on the GLA01 tab, unselect the "Obs Mean Background, Volts", "Observed Background Std Dev, Volts" and "Tx Pulse, Volts". Press the "Apply properties" button. Now you have left the return pulse in red and the standard fit in blue. The vertical blue lines show signal-begin and signal-end using the standard parameters.

5.1.2 **Turn off the standard fit curves:** Click the "Curves.." button. On the "GLA05 Std Fit" tab, unselect the "Model, (Standard Fit), Volts" curve and the "Signal Range" (Std Fit) curve. Press the "Apply properties" button. All you see is the red return pulse curve now.

5.1.3 **Check the alternate fit**: Click the "Curves…" button. On the "GLA05 Alt Fit" tab, select the "Model, (Alternate Fit), Volts" curve and the "Signal Range" (Alt Fit) curve. Press the "Apply properties" button. This shows you the alternate fit in a bright green color. Change the color by clicking on the "Properties" buttons by the two curves and changing the color. Press the "Apply properties" button when done. Exit the curves window by pressing the "Dismiss window" button.

5.1.4 **Look at individual waveform flags**: Click the "Show Flags" button. A window with an interpretation of the waveform quality flags pops up. This shows you which regional mask (the detailed mask, not the on-board mask) the data is in and any problems with the waveform. You must click the "OK" button in this window to remove it before you can continue.

5.1.5 **Change plot properties to zoom waveform:** Click the "Plot Properties…" button then "Modify Plot Properties…". Change the y-

range from 0.0 to 1.4 and the x-range from 200.0 to 600.0. Push "OK". Note the waveform plot is immediately replotted with these properties.

5.1.6 Close "**ZOOMED WAVEFORM**" window. Push "DONE" button in the top right hand corner.

5.1.7 **Page through the waveforms.** Bring the "WAVEFORMS" window to the foreground by clicking in it. Be careful: if you click on a waveform plot you will bring up a zoomed waveform. Just close it if you do. You can scroll backwards and forwards by either one waveform, by pushing "< previous" or "next>"; or by a complete page of 20, by pushing "<<page" or "page>>". The red vertical line on the elevation plot set window moves with you.

Step 6.0 **Pick another track within original selection.** Close the "WAVEFORMS" window by pushing the "DONE" button in that window. Close the "GLAS ELEVATION" plotset by pushing the "Done" button in that window. Close the "GLAS Series Plot Sets" window by pushing the "Done" button in that window. Bring the "Elevation PROFILES" window to the foreground. Click on a different Elevation profile. That track will be highlighted in the "groundtracks" window and the "GLAS Series Plot Sets" window reappears with the new pass number.

Step 7.0 End program. Close any windows you have open that have a "done" button by clicking it. You should be left with the "Groundtracks" and "Elevation Profiles" windows open. Click the "Back to Data Selection" button in the "Elevation Profiles" window to close all windows except for the data selection window. If you are exiting the Visualizer, press the "Exit" button.

A.2) Lidar Exercise

The purpose of this scenario is to look at the atmosphere data to see what the calibrated backscatter profiles and images look like. This exercise looks at GLA07 and GLA09.

Step 1.0 If the data selection window is still up from the last exercise, then press the "Data Product Menu" button and select products GLA07 and GLA09. Press the "Continue" button on the data selection window to bring up the data. If the Visualizer is not up, follow step 1.0 in section A.1 to invoke the Visualizer and select data. Select products GLA07 and GLA09 rather than GLA01 and 5. When the "Cloud Images" window comes up, click on one of the plots.

Step 2.0 Select what set of parameters to view. In the "**GLAS Series Plot Sets**: Pass …" window the parameters have been grouped by subject matter into plot sets. The plot sets available to look at are dependent on what products you selected. Since GLA07 and GLA09 products were selected, you should see the following plot sets highlighted:

- Elevations
- Angles
- Meteo, Cloud, Aero Parameters
- Normalized Lidar Image, 532nm
- Normalized Lidar Image, 1064nm
- Attenuated Backscatter Image, 532nm
- Attenuated Backscatter Image, 1064nm
- Energies and Backgrounds
- Flags

Click the boxes next to "Attenuated Backscatter Image, 532 nm", "Attenuated Backscatter Image, 1064 nm", and "Energies and Backgrounds". Then push the "Display Selected Plotsets" button. It will take a minute or so to load the parameters. Three windows will appear: one with "GLAS 532nm Attenuated Backscatter", one with "GLAS 1064nm Attenuated Backscatter", and one with "GLAS LIDAR ENERGY". It's interesting to notice the difference between the 1064 nm and 532 nm channels. Close the "GLAS 1064nm Attenuated Backscatter" window by pressing the "Done" button when done.

Step 3.0 **GLAS LIDAR ENERGY** window: Initially the 532 and 1064 nm transmitted energy profiles are plotted.

3.1 The energy values do not show up very well on this initial plot. Change the plot properties to customize plots. Click the "properties" button directly under the "Curves" button. A new window appears that allows you to change plot and axes titles, the x range and the y range, the format of the tick mark labels, and the type of plot (log or linear). Change the y range to go from 0 to 0.1. Push "OK" button in bottom of window. You now should just see the portion of the curve that lies between 0 and 0.1 Joules.

3.2 Change properties of specific curve. Press the "Curves…" button. A window appears showing you what parameters are available to plot in this window. Go to the "532nm Transmit Energy (J) 5Hz" curve. The Show button will be indented indicating that the curve is displayed. Select the "Properties" button next to the curve. A new window will pop up that will allow you to change the curve properties of just this parameter. Click the radio button next to "green". Then push the "OK" button in bottom of window. Now press the "Apply properties" button on the curves window. Note that the 532 Energy at 5 Hz is now shown in green.

3.3 Repeat the step above, but click on "Output" instead of "Properties". You may see the x and y data values output to a window by selecting either of the "Show (…) in window" buttons. To output the values to a file, select either "Programmer style to file" or "Spreadsheet style to file". "Programmer style" writes the entire X array, followed by the entire Y array; this is easier for programs like IDL to read. "Spreadsheet style" writes the X and Y arrays as columns. A new window pops up that lets you choose the file in which to write the data. Make sure you have write permissions in the directory in which you are creating the file, or change the directory appropriately. If you accept the default, it will go in the directory you were in when you invoked the Visualizer as the default file for that parameter. If the file already exists, this data will be concatenated onto the existing portion of the file. Click OK to write the data to the file.

3.4 Remove the energy curves by clicking "**Hide all curves**" then "Apply properties" in the curves window.

3.5 **Look at the difference** between transmitted energies. Click the "Choose Curves" button by the difference plot at the bottom of this window. Choose the "532nm Transmit Energy (J) 40 Hz" as the first curve and the "532nm Transmit Energy (J) 5 Hz" as the second curve. Press "Apply selection" when done. The difference plot now shows the difference between these two transmitted energy values.

3.6 Zoom – use the turquoise zoom bars to zoom a portion of the x direction. Click and drag each zoom bar to where you want it. The zoom range is shown in seconds in the text buttons above the curve. Click the "Zoom" button (upper right) to zoom.

3.7 Show region on ground track. Push the "Show on Ground Track" button for this zoomed window. Bring the "Groundtracks window" into the foreground by clicking on it and see that this portion is highlighted on the groundtrack. Select "Greenland" and press "Replot Map" to see a close-up of the region. If you right-click on the zoomed plot to see the red line then press "Show on Ground Track", the teal cube changes position.

3.8 Get rid of windows. Bring the zoomed "GLAS LIDAR ENERGY" window to the foreground by clicking on it, and push the "Done" button in the top right hand corner. Then do the same with the original "GLAS LIDAR ENERGY" window.

Step 4.0 Bring the "**GLAS 532 nm ATTENUATED BACKSCATTER**" window to the foreground. This is the GLA07 attenuated backscatter profile image overlaid with GLA09 cloud layer data. By default, only the part from -1km to 20km altitude is shown; if there is any cloud data above 20km, the full range to 41km is shown. You may change this by using the "Properties" button to modify the plot's Y range.

4.1 Zoom – use the turquoise zoom bars to zoom a portion of the x direction. Click and drag each zoom bar to where you want it. The zoom range is shown in seconds in the text buttons above the curve. Click the "Zoom" button (upper right) to zoom. Press the "Done" button when finished looking at the zoomed image.

4.2 Right clicking on the image, then clicking the "Display Lidar Profiles" button will bring up individual thumbnail profiles. There is one thumbnail profile for every laser shot. The caption on each profile lists the unique index (NOT UTC!), shot number, latitude, longitude, and solar angle.

4.3 Page through the thumbnail profiles. You can scroll backwards and forwards either by a single laser shot, by pushing "< previous" or "next>"; or by an entire page of 20, by pushing "<<page" or "page>>". The red vertical line on the lidar energy plot set moves with you.

4.4 Click on one of the profiles to zoom it. The curves plotted include:

- 532 nm attenuated backscatter at 40 Hz
- 532 nm attenuated backscatter at 5 Hz
- 1064 attenuated backscatter at 40 Hz
- 1064 attenuated backscatter at 5 Hz
- 532 nm molecular backscatter X-Section
- 1064 nm molecular backscatter X-Section

4.5 Close "ZOOMED WAVEFORM" window. Push the "DONE" button in the top right hand corner. Bring the "LIDAR" window to the foreground and push the "DONE" button in the top right hand corner to close it.

Step 5.0 If the "**GLAS 532nm ATTENUATED BACKSCATTER**" window is not in the foreground, bring it there. On the image are plotted the cloud and aerosol layer heights (tops and bottoms separately), and the ground detection. They are available at different resolutions.

5.1 Zoom – use the turquoise zoom bars to zoom in on a portion of the image. Choose an area that shows several cloud layers. Then push the "Zoom" button to zoom.

5.2 Bring the zoomed window to the foreground. The many curves make the plot somewhat difficult to follow, so click "Curves…", "Hide all curves", "Apply properties" to turn them off.

5.3 With the curves window still up, select from the GLA09 curve list,"DEM Height (m)" by indenting the button under "Show", and then click "Apply properties".

5.4 Now turn on some cloud layers. Select from the GLA09 curve list "Cloud Top (m) Level 1 Low Res" then click "Apply properties" to display. Notice that several horizontal bars appear… these are the top of the first cloud layer.

5.5 Select from the GLA09 curve list "Cloud Bottom (m) Level 1 Low Res" then click "Apply properties" to display. The bottom of the first cloud layer is now shown in magenta. (Cloud layers are counted from the top down.)

5.6 Repeat steps 5.5 and 5.6 for Level 2 and then for Level 3. Each time, notice the new bars that appear.

5.7 For the "Differences" plot at the bottom of the window, click the "Choose Curves" button. Under the GLA09 curve list, choose "Cloud Top (m) Level 1 Low Res" as the first curve and "Topographic Elevation (m)" as the second curve. Press "Apply selection" when done. The difference plot now shows the height of the first cloud top above the topography.

Step 6.0 Now bring each of the "**GLAS 532nm ATTENUATED BACKSCATTER**" windows to the foreground and close by pushing the "DONE" button. Finally, bring the "GLAS Series Plot sets" window to the foreground and push the "DONE" button to close it.

Step 7.0 Pick another track within original selection. Bring the "**Cloud Images**" window to the foreground. Click on a different lidar image. That track will be highlighted in the "groundtracks" window and the "GLAS Series Plot Sets" window reappears with the new pass number.

Step 8.0 End program. Close any windows you have open that have a "done" button by clicking it. You should be left with the "Groundtracks" and "Cloud Images" windows open. Click the "Back to Data Selection" button in the "Cloud Images" window to close all windows except for the data selection window. If you are exiting the Visualizer, press the "Exit" button.

Appendix B: Abbreviations & Acronyms

GLAS	Geoscience Laser Altimeter System
GSFC	Goddard Space Flight Center
GUI	Graphical User Interface
ICESat	Ice, Cloud, and land Elevation Satellite
IDL	Interactive Data Language
ISF	Instrument Support Facility
I-SIPS	ICESat Science Investigator-led Processing System
ITTVIS	ITT Visual Information Solutions, manufacturer of IDL
LIDAR	LIght Detection And Ranging
LPA	Laser Profiling Array
mSCF	Main Science Computing Facility
NaN	Not a Number
NASA	National Aeronautics and Space Administration
NSIDC	National Snow and Ice Data Center
rSCF	Remote Science Computing Facility
TOO	Target Of Opportunity
UIX	Unique Index
UTC	Universal Time, Coordinated
UTCSR	University of Texas Center for Space Research